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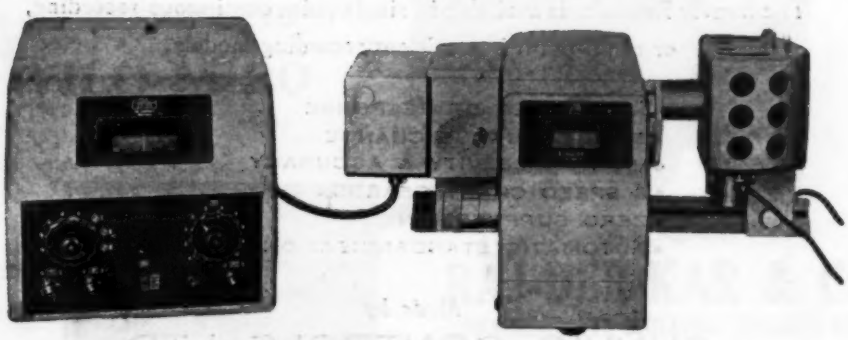

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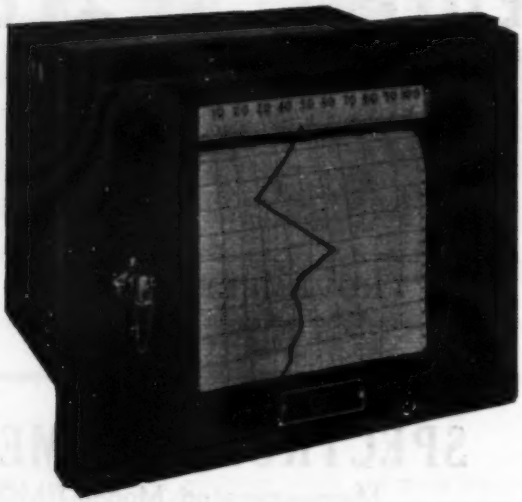

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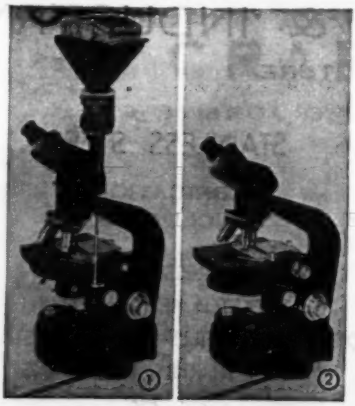

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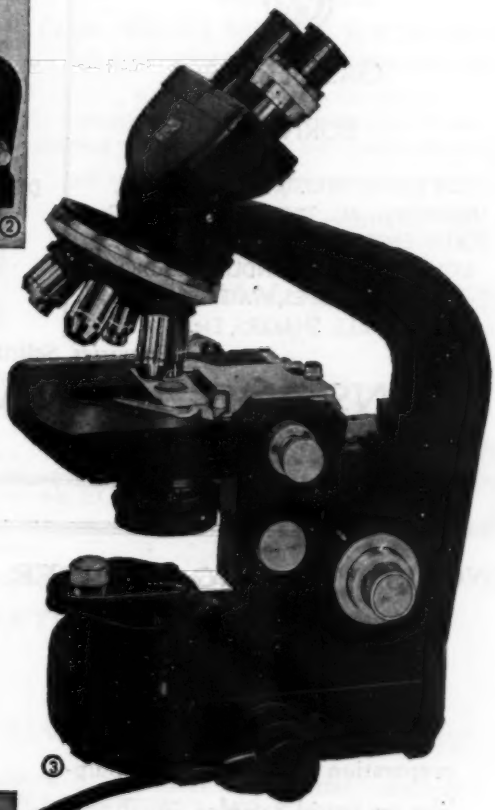

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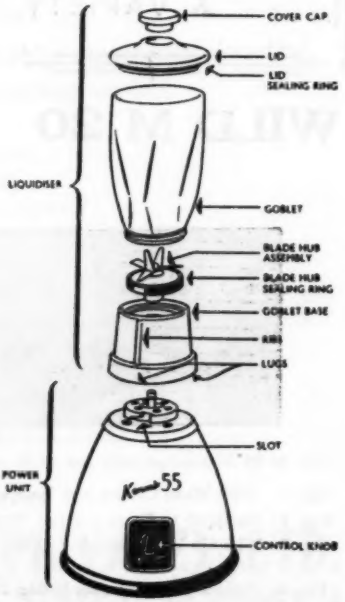

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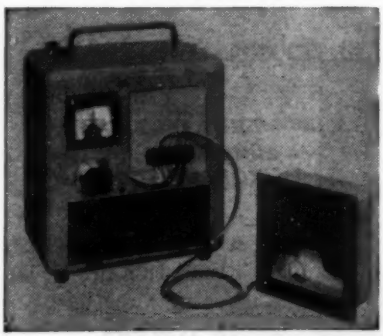

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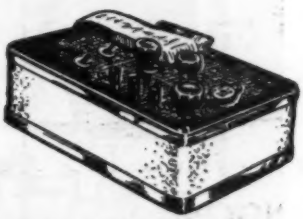

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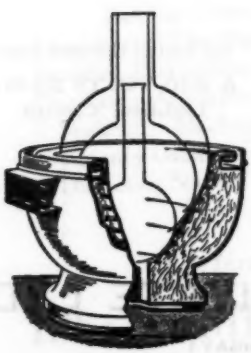

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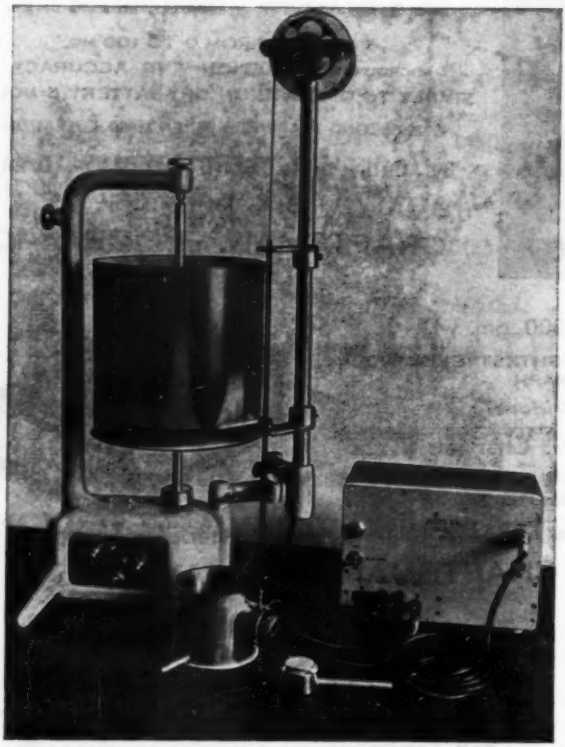

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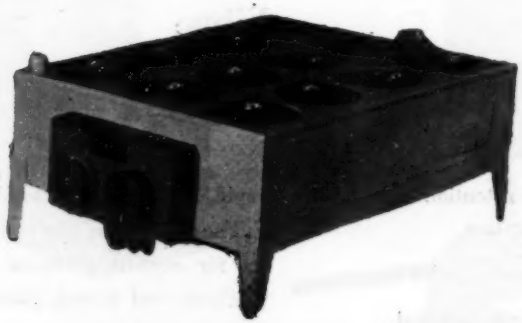

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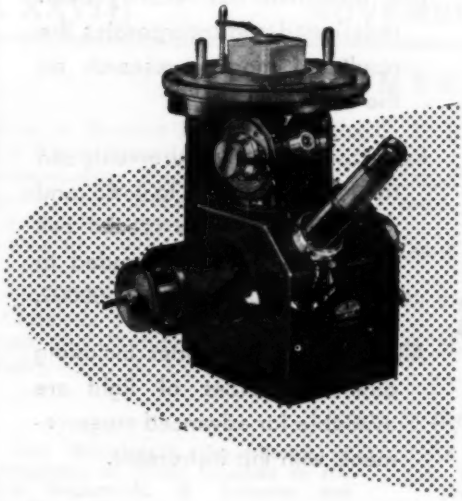

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SCIENCE IN EASTERN EUROPE: II

SIR C. V. RAMAN

6. BUCHAREST

LEAVING Budapest in the forenoon of the 28th of June, we arrived at Bucharest early next morning and remained there till late at night on the 7th of July. During our stay we were the guests of the Rumanian Academy of Sciences and the Rumanian Institute for Cultural Relations with Foreign Lands. These two organisations took it upon themselves to make our sojourn in Rumania a most interesting experience. The enthusiasm and cordiality with which we were received and entertained cannot easily be described.

Three days, namely, the 2nd, 3rd and 4th of July were devoted to the preparation and delivery of a course of three lectures on the "Physics of the Diamond". The hall of the Academy where the lectures were delivered was filled to capacity on all the three evenings. In giving these lectures, I had the assistance of Dr. Gavrila, a young theoretical physicist who spoke and understood English very well. The main points of each lecture were discussed with him and written out in advance and he could therefore translate my lecture as delivered orally in a perfect manner. The results were satisfactory both to myself and to the audience.

A notable recent development in Rumania is an Institute of Atomic Physics which has been built a few miles away from Bucharest and is accommodated in a group of buildings, the two largest of which contain respectively an atomic reactor and a cyclotron with their controls and accessories. As the Director of the Institute, Academician Hulubei, was away in Geneva at the time of my visit, I was shown round the Institute by the members of the staff. The latter includes Academician Ţiţeica who is the leader of an active school of theoretical physics. I also paid a visit to the Institute of General Physics at Bucharest of which Academician Bădărău is the Director. I was shown round the various laboratories in which I found much valuable work in progress in diverse fields and had the pleasure of learning about the details of that work individually from Prof. Bădărău's colleagues. I was also much interested in the arrangements made to give a preparatory course of experimental work in nuclear physics to the University students.

During our stay at Bucharest I had the pleasure of meeting the Prime Minister of Rumania at his office and had a long and interesting conversation with him. The Prime Minister gave me a detailed account of the progress being made by Rumania in the economic, educational and scientific spheres and expressed with sincerity and emphasis his desire that Rumania should come into much closer relationships with India in various fields of activity for their mutual benefit.

Two days were devoted to a tour by motor from Bucharest to Ploesti up the valley of the river Prahova to the mountains and back. On our way we passed through the region where the famous Rumanian oil wells and the oil refineries are located. The terminus of our tour was at Sinaia, a well-known hill resort at which we made a short stay. From the verandahs of our lodge we could see the mountains encompassing Sinaia. We motored to a hotel perched up on the heights and on our way back visited the Peleş Castle, formerly a royal residence and now a public museum which has lovely gardens and terraces with beautiful views on every side.

That Rumania has an active scientific life and an intellectual climate favourable to achievement was very evident. An extensive scientific literature exists in the language of the country, merely as a sample of which

I may mention a book on the physics of the solid state written by the young physicist Sergiescu and a book on the acoustics of the violin by Professor Bianu, copies of which the authors were good enough to present to me.

We had a wonderful send-off from Bucharest. At the station we were handed two beautifully bound albums containing photographs of our visits respectively to the Institute of Atomic Physics and the Institute of General Physics.

7. Belgrade

Yugoslavia lies on the railway route between Rumania and Italy, and in our travel programme which had been arranged in advance, two weeks had been set apart for a journey through that country with a stop-off at each of its three chief cities, *viz.*, Belgrade, Zagreb and Ljubljana. The holiday season had however already begun and I was under the impression that the time chosen for the visit to Yugoslavia was not a suitable one for making any useful contacts with its scientific men. This anticipation, however, turned out to be false. Nawab Ali Yavar Jung who is the Ambassador of India at Belgrade is an old friend of mine. He welcomed us on arrival and told us that he had taken the initiative in arranging a programme for our stay at Belgrade. This, in the event, proved to be highly interesting and fruitful.

Belgrade is the capital of Serbia and has been the scene of many conflicts in its past history. It is now also the capital of the Federal Republic of Yugoslavia. The city is situated near the confluence of the Sava and the Danube which join here to form a single mighty stream. Standing on the ramparts of the ancient fortress of Belgrade, one sees an impressive panorama over the rivers and the neighbouring city of Zemun. Very appropriately also, in the Citadel of Belgrade have been set up the memorials of the recent conflict in which the partizans under the leadership of Marshal Tito successfully defended their country against the armies of Hitler.

Professor Milojevič of the Physical Institute of the University of Belgrade had arranged for a lecture by me on the 9th of July following the day of our arrival. Professor Savič took the Chair and I expounded as briefly and as clearly as possible the ideas regarding crystal physics which had emerged from the Bangalore investigations. On each of the three following days (10th, 11th and 12th of July) I visited the Institute of Nuclear Sciences which had been set up by the Federal Government. The Institute is located at Vincha about fifteen kilometres away from Belgrade and the motor road leading to it took us through some lovely countryside, and Vincha itself is most picturesquely situated. I was warmly welcomed at the Institute by Director Popovič who is in charge of the administration and by Professor Savič who is in charge of the scientific activities. Great progress had been made in building up and equipping the Institute and further developments were in full swing. I found many young scientists at work and much activity in the laboratories.

On the 11th of July, I gave a lecture at the Vincha Institute in which I expounded my ideas regarding the structure of diamond and the explanation of its properties. Prof. Savič presided at the lecture and led the discussion which followed it. The rest of my time at the Institute was taken up in visiting its various departments, viewing the equipment which had been set up or was being set up and discussing the investigations in progress with the workers in its laboratories. In the evening of the 12th of July, I visited the Serbian Academy at Belgrade of which Professor Belič and Professor Kasanin are respectively the President and Vice-President. The Mathematical Institute of the Academy which I inspected is an active organisation and has a fine library. The publications of the Institute are regarded with respect in mathematical circles everywhere.

Our hosts of the Institute and the Academy did their very best to give us a happy time. On the afternoon of the 11th of July, there was an excursion to the hill-top of Avala, a few miles out of Belgrade, on which a highly impressive monument to the Unknown Warrior stands. Extensive views are to be seen on all sides from the monument. On Sunday the 13th of July, we were taken on an all-day motor tour through the Serbian landscape. We visited the valley of the Danube and saw several of its beauty-spots.

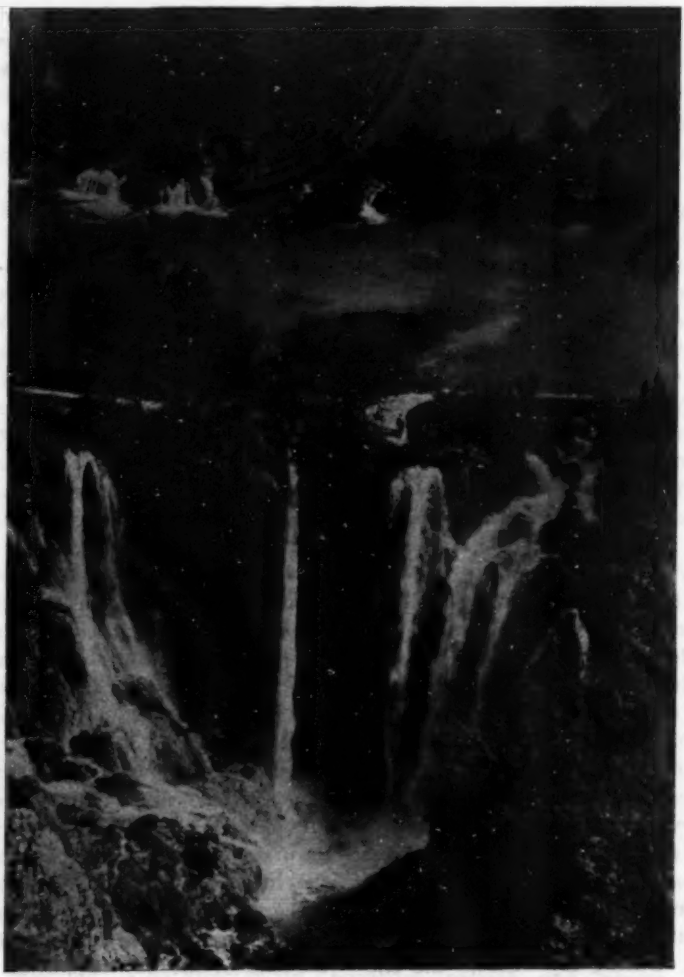


FIG. 3. The Plitvice lakes, Yugoslavia

8. ZAGREB

As had been planned earlier, we were at Zagreb for three full days, arriving on Monday evening, the 14th of July and leaving for Ljubljana on the forenoon of Friday the 18th. The holiday season was in full swing and we travelled in a train which was very crowded, but the special consideration which was given to us by the railway staff saved

us from discomfort. We were met at the station by Dr. S. Asperger and taken to our hotel.

Croatia is one of the several Republics which have federated to form Yugoslavia. It includes a great part of the coast-line of that country from Fiume in the north to Kotor in the south, as also an immense number of islands, great and small, in the Adriatic Sea. Zagreb is the capital of Croatia, and is a large city. The river Sava runs a few miles south of it while immediately to the north of the city are some high hills which help to make Zagreb and its surroundings very picturesque.

Local patriotism runs strong in Yugoslavia, and since a great new Institute of Nuclear Physics is going up at Belgrade, it was only to be expected that Zagreb would not lag behind. Indeed, our visit to Zagreb, brief though it was, owed its great interest to us by reason of that very circumstance. On the rising ground between the city and the mountains a great new Institute had been set up named quite appropriately as the Boscovitch Institute after the great pioneer of an earlier age in the field of atomic physics. The Institute is by no means a duplication of the effort which is building the organization at Belgrade. The scientific ideology animating the Boscovitch Institute is indeed different, embracing a wider range of scientific topics. Nuclear physics was of course represented and indeed showed every sign of being an active field of interest at Zagreb. The fitting up of a laboratory containing a large cyclotron was in an advanced state of progress. Prof. Paić also showed me the equipment that he had set up for investigating the behaviour of atomic nuclei under neutron bombardment. During my visit to the chemical laboratory of the Institute, I was much impressed by the work being done by Dr. Asperger on the detection of traces of mercury in the atmosphere by its effect upon the rate of chemical reactions. This is a subject of practical importance, since Yugoslavia is an important producer of mercury from its naturally occurring minerals.

An interesting function at which I was present was the final examination for the Doctor's Degree in Physics of two young aspirants for that distinction. I sat alongside of the Board of three Examiners which consisted of three professors of the Zagreb University. In view of my presence at the examination, the candidates were asked to give the oral presentation of their theses in the English language. That they could do so and very well indeed was not surprising, since the experimental work of one candidate was done at Cambridge in England and by the other at Rochester in U.S.A. The *viva voce* examination which followed the oral presentation of the theses was very searching, but the candidates showed up very well. I felt that the system followed at Zagreb of having only internal examiners for the doctorate was an admirable one which was worthy of being followed elsewhere.

Apart from the activities referred to above, our three days at Zagreb were fully occupied. On Tuesday the 15th of July, I spoke on the problems of crystal physics at a colloquium at which Dr. Supek and his colleagues in theoretical physics were present. The discussions with him on this and other topics were continued later in the day when he drove us up to a mountain lodge some miles behind Zagreb where we spent a few happy hours wandering through the woods. The next day, Prof. Paić and Mrs. Paić took us out on an all-day motor excursion in the course of which we visited the medieval town of Karlovie and thence proceeded to the famous national park containing the Plitvice lakes. Here we spent the rest of the day exploring the lakes, returning to Zagreb late in the evening, tired but happy. To describe the Plitvice lakes adequately and convey an impression of their transcendental beauty would need a whole article to itself. We can only reproduce here a photograph of a very small part

of the region including the waterfalls characteristic of the area.

On the third day, the 17th of July, we were entertained by Prof. Paić and Mrs. Paić at their home. They bid us an affectionate farewell next morning at the station when we left for Ljubljana.

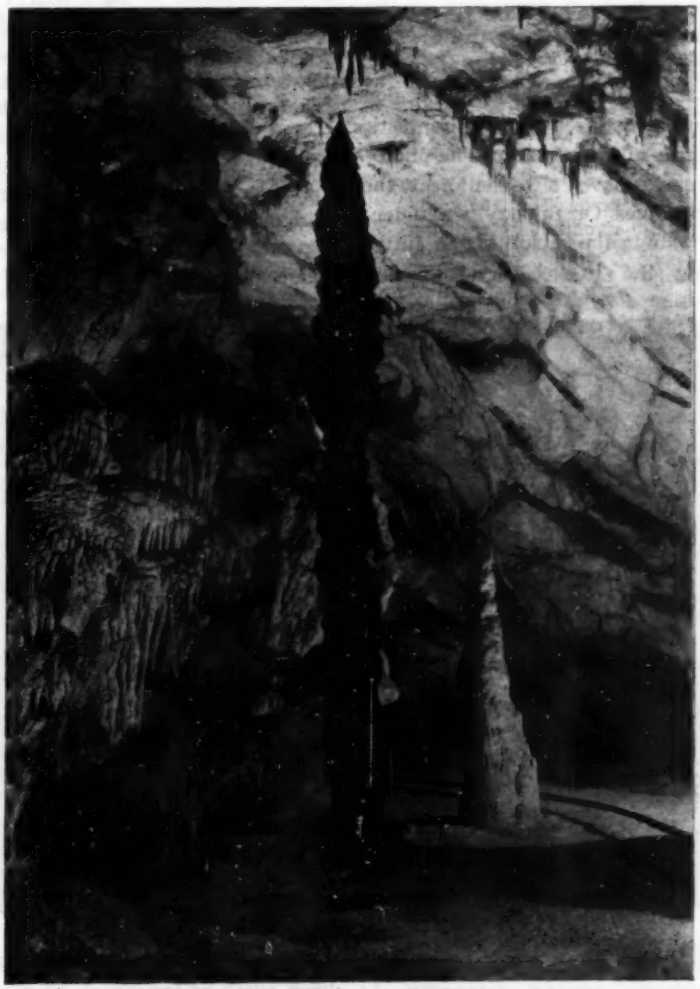


FIG. 4. Near the entrance to Posthumia caves

9. The Rest of the Tour

My scientific activities ceased when we left Zagreb. But a brief reference to the later parts of the tour may be of some interest to the readers of *Current Science*. The railway journey from Zagreb to Ljubljana is not a long one. It took us through the beautiful valleys and gorges which the river Sava has made for itself in flowing through Slovenia. Ljubljana itself is a charming town with a medieval castle on a hill right at its centre and a great city park extending into the hills. The day after our

arrival, we drove up to the celebrated limestone caves at Posthumia which lies halfway between Ljubljana and Trieste. These caves run for several miles underground, and indeed one has to make a good part of the journey within them by electric trolley. The rest of the journey on foot through the cavernous interior takes us through a region of which the magnificence and fantastic character beggars all description. The photograph reproduced shows a region near the entrance to the caves. On Sunday, we undertook a motor tour to the region of the Julian Alps including the two lakes, Bled and Bohini which lie in that area. Lake Bled and its environs appear comparatively sophisticated. The picture reproduced shows the church on an island in the lake and the Julian Alps beyond. Lake Bohini which is much further west is not far from Triklav, the highest peak of the Julian Alps. It lies right at the foot of the mountains and has a sombre beauty of its own.

Leaving Ljubljana on the morning of the 21st, we travelled *via* Trieste and the coast of the Adriatic to Italy and Venice, reaching the latter city the same afternoon. We spent the next day at Venice visiting its palaces, the Lido and the lagoons. The next day, again, we toured through Venetia by motor, viewing its many beautiful villas with their Palladian architecture. Crossing the river Brenta by its celebrated wooden bridge, we went as far as Asolo before finding our way back to the Grand Canal of Venice and our hotel.

FIG. 3. Lake Bled and its island

The evening of the 24th of July found us back again at Innsbruck where we remained three days. Innsbruck is a convenient centre for visiting the surrounding regions in Austria, Italy and Germany. The opportunities thus open to us were fully utilised before we left finally to catch our steamer at Genoa.

NOBEL PRIZE AWARDS FOR 1958

Physics

THE Nobel Prize for Physics has been awarded to the three Soviet physicists, Pavel A. Cherenkov, Ilya M. Frank and Igor E. Tamm, for the discovery and interpretation of what is known as the "Cherenkov Radiation". This is the visible radiation produced in a dispersive medium by charged particles which move with a velocity greater than that of light in that medium. Nearly 25 years ago, P. A. Cherenkov of the Physical Institute of the Academy of Sciences of U.S.S.R., Moscow, reported his discovery of "feeble visible radiation emitted by pure liquids under the action of fast electrons—beta particles of radioactive elements or Compton electrons liberated in liquids in the process of scattering by gamma-rays" (*Phys. Rev.*, 1937, *52*, 378).

According to the theory of relativity a material particle cannot travel with a velocity v greater than c, the velocity of light. However, we know that in a dispersive medium of refractive index n, light waves travel with the phase velocity $u = c/n < c$. Also we know that hard cathode rays and Compton electrons produced by very hard gamma rays attain velocities in the range $u < v < c$. What happens in this velocity range?

For velocities below that of light in the medium the electron carries its own field with it and no energy is radiated. But for velocities above that of light in the medium, the electron leaves its field behind in the shape of a Mach cone. The field radiates in directions perpendicular to the surface of the cone, and because of the nature of dispersion, this radiation consists mainly of visible light. The radiated light is polarized so that the electric vector lies in the plane passing through the trajectory of the electron. This is the Cherenkov Radiation.

Frank and Tamm calculated the field of the Cherenkov electron and showed that (*i*) the field was zero everywhere outside the Mach cone and (*ii*) an electromagnetic field existed everywhere in the interior of the Mach cone.

To produce Cherenkov radiation it is best to use a thin resin plate on which the electrons impinge perpendicularly. Thus only a small portion of the Mach cone appears, and the emitted radiation fills a thin annular cone perpendicular to that portion. The exposed area on a photographic plate, placed behind the resin plate, renders the annular trace of this cone visible.

It is interesting to note that because in quantum mechanics one is forced to decompose the electromagnetic field into its Fourier components from the very start, the quantum mechanics treatment of the Cherenkov effect leads directly to a representation of the field in which dispersion can be taken into account, and therefore the visible character of the Cherenkov effect is directly put in evidence.

One important application of the Cherenkov effect is the Cherenkov detector for high energy particles. The bursts of Cherenkov radiation emitted by high velocity particles passing through a dielectric medium may be detected by a photoelectric cell, followed by an electron multiplier, and thus give rise to signals recording the number of particles passing through the given dielectric object. The discovery of antiproton in 1955 at the University of California would have been difficult without the Cherenkov detector.

Chemistry

British scientist Dr. Frederick Sanger of Cambridge has been awarded the Nobel Prize for Chemistry for his work in determining the composition of the insulin molecule. Dr. Sanger worked for 12 years on this problem and found that there were 777 atoms in the insulin molecule. This is the first time the structure of any protein has been determined. As science learns more about protein molecules, it will know more about how disease attacks the body.

Medicine

The winners of the Nobel Prize for medicine are the three American scientists Dr. George Wills Beadle, Professor of Biology at the California Institute of Technology in Pasadena; Dr. Edward L. Tatum of the Rockefeller Institute for Medical Research, New York; and Dr. Joshua Lederberg, Professor of Genetics at the University of Wisconsin.

Their work concerns the actual basis of heredity—the way in which characteristics are transmitted from one generation to another. Their technique has become one of the most important tools in the study of cell metabolism. Now widely used, it has given important results in various biological and medical problems.

THERMONUCLEAR ENERGETICS

PROF. G. BABAT

Director of Technical Sciences, U.S.S.R.

WHEN the firing pin of a toy gun strikes the cap, a low crackle is heard—that is, a miniature explosion.

The stroke of the firing pin makes some of the molecules of the explosive move at a greater speed, and they collide with others. When the impulses are sufficiently strong the molecules break up and their atoms form new and more stable combinations. The molecules' change-over—the explosion—may be compared to the crumbling of a column of bricks due to an impulse. Such a column is a system which is mechanically stable only within certain limits. Where the jolt is sufficiently strong the bricks fall into a heap, which is a more stable system and which has a smaller margin of energy than the high column. What is stable only within certain limits and at a sufficiently strong impulse passes into a more stable state is called a metastable system. Metastable systems are storehouses of power.

Fulminate of mercury, out of which caps are made, is chemically metastable. There are many chemical metastable systems, such as a mixture of molecules of benzine and oxygen. Under the proper impulse (mechanical blow, heating, electric spark) the molecules change over during which energy is released.

Besides chemical and mechanical metastability, there is also nuclear metastability; the nuclei of uranium, thorium and plutonium are examples of it. Under the proper impulse these nuclei disintegrate, split up; the nuclear particles group themselves differently, forming new, smaller and more stable nuclei, and the surplus energy is released.

It is on the use of the energy released in the splitting up of uranium that nuclear energetics is based. Nuclear electric stations under construction in the Soviet Union are all uranium electric stations.

Hydrogen, which is a component part of all rivers, seas and oceans, is also a nuclear-metastable substance, and the nuclei of hydrogen are storehouses of energy. However, this energy cannot be released by fissure, as the nuclei of ordinary hydrogen—protons—do not lend themselves to further splitting, but the reverse, by the fusion of the nuclei, their synthesis. If there is a sufficiently strong jolt, under the proper conditions, four nuclei of ordinary hydrogen will fuse, producing a nucleus of helium.

When a brick column crumbles, the specific energy (energy per unit of mass) released thereby will be relatively little. Where chemical metastable systems change over the specific energy is many times greater. And even more energy is released during nuclear reactions. As much energy is released during the break-up of atomic nuclei in 1 g. of uranium as in the burning of 3 tons of coal. In the synthesis of helium from hydrogen, almost 20 times as much energy is released per gram of hydrogen as per gram of disintegrating uranium.

In reactions caused by the splitting of nuclei of uranium, various radioactive products are produced, and considerable difficulties raise in removing and preserving these "ashes" which emit dangerous ionizing radiations.

Hydrogen is used in thermonuclear processes.

There is much hydrogen on earth, many times more than uranium. Hydrogen is found in an easily available state, for which reason mastering the reaction of "burning hydrogen into helium" opens up boundless prospects for humanity.

However, there is one thing in the way of applying the energy contained in the nuclei of hydrogen for peaceful purposes.

To disturb the equilibrium of any metastable system and release the energy latent in that system some impulse has to be given, some initial expenditure of energy has to be made.

In order to pull down the brick column which we offered as an illustration of a mechanical metastable system, it is enough to strike the column with some heavy object—a hammer or a stone—at a velocity of but a few score metres a second, but to bring out a chemical metastable system from a state of rest greater concentrations of energy are required. For instance, to make molecules of benzine and oxygen change over into molecules of water and carbon dioxide gas, the molecules have to strike one another at a velocity of not less than several hundred metres a second.

And to excite nuclear reactions many times greater, initial specific energies are necessary.

Like the nuclei of all atoms, the nuclei of hydrogen carry a positive electrical charge; the nuclei are incredibly small in size, and when two equally charged hydrogen nuclei

approach one another closely colossal repelling forces arise between them. In order to make two nuclei of hydrogen collide they have to be imparted a velocity millions of times greater than the velocity which is sufficient to excite chemical reactions in the collision of molecules.

The movement of particles of matter can be accelerated by heating them. Temperature is, strictly speaking, one of the measures of velocity of the particles of matter: the higher the temperature, the faster the particles move. Raising the temperature is a thermal method of exciting reactions. At a temperature above 1,000° an immense number of chemical reactions take place.

Nuclear reactions too can be excited by heating; such reactions are called thermonuclear. However, they require temperatures millions of times higher than the temperatures of chemical reactions.

In the interior of the Sun and other stars, temperatures reach tens of millions of degrees, and it is such a temperature which produces the reaction resulting in the synthesis of helium from hydrogen. This reaction is the source of the heavenly bodies' energy.

In terrestrial conditions, a temperature of the order of millions of degrees cannot be produced to continue for a protracted time either in solid or liquid matter. In compact matter, pressures of millions of atmospheres arise under such temperatures. As the temperature rises the particles of matter break up and scatter on all sides in a thousand-millionth part of a second.

Everyone has had occasion to see red, blue or green lights in the show windows of shops or outside cinema theatres. Those are the lights of rarefied gases in glass tubes through which an electric current is passed. As a result of the action of the electric current, a mixture of electrons and atoms which have partially or completely lost their electrons; this mixture physicists call "plasma". In plasma, matter is in an extremely rarefied state, with a cubic metre of it weighing less than a pinhead. And it is in such plasma that electrons and atomic nuclei can gain the high speeds corresponding to the super-high temperatures.

In recent years, attempts have been made in many laboratories all over the world to produce astral temperatures by passing the most powerful electric currents possible through rarefied gas.

Using currents of millions of amperes, Soviet scientists have produced "astral matter" in terrestrial conditions. A tube made of insulating material is equipped at both ends with electrodes to which high-voltage current is delivered from a large battery of condensers. Under the action of the electric forces, the charged particles—electrons and nuclei of the atoms—move at great speed inside the discharge tube from one electrode to the other. An electromagnetic field appears around the flux of charged particles, compressing the flux, as though insulating it from the surrounding medium.

The magnetic lines of forces produce a "heat-proof magnetic bottle". But how stable is it? How long can the blob of the super-incandescent plasma survive? Will there be enough time for thermonuclear reactions to take place in the magnetic bottle? In recent years, considerably more attention has been given to working out theoretically and experimentally magneto-electro-hydrodynamics—the science of the behaviour of plasma streams in electromagnetic fields.

As far back as 1950, Academicians A. D. Sakharov and I. E. Tamm suggested the first model of a magnetic thermonuclear reactor. This work was later carried on in the U.S.S.R. in a number of directions and today several groups of scientists and engineers are engaged in it. One of the groups, headed by Academicians L. A. Artsimovich and M. A. Leontovich, have succeeded in producing the emission of neutrons by heating rarefied deuterium to a temperature of more than a million degrees.

Suggestions have been made to form groups of hydrogen nuclei in a high vacuum instead of in a gas: to release a stream of hydrogen nuclei from a large surface and then concentrate the stream by means of electronic optics into a common centre, group them into a compact blob in which the fast-moving nuclei will collide and react.

Experiments are being conducted to produce thermonuclear reactions in the so-called annular electrodeless electric discharges. In these discharges, the charged particles move in a close circle like grains of dust in a whirlwind. The charged particles form in the discharge chamber something like a ring of smoke which experienced smokers know how to blow.

Electrodeless discharges have been known for a long time. Already, before World War II, the author of this article built outfits for investigating electrodeless discharges at capacities of several hundred kilowatts. Today electrodeless discharges are being studied intensively in connection with thermonuclear reactions.

Data have recently been published about the British Zeta outfit. It has a doughnut-shaped

discharge chamber, three metres in diameter and one metre thick. Permeating the chamber is an electromagnetic current produced by the winding through which a condenser battery is discharged with a margin of energy of up to 500 kilowatt seconds. The plasma cord forms a ring of fire in the discharge chamber. It is a secondary shorted winding, and the strength of the current in the curl of the ionized gas reaches 200,000 amperes and a temperature of 4,000,000 degrees.

In the United States an outfit known as the Sherwood has been designed which also has a doughnut-shaped discharge chamber.

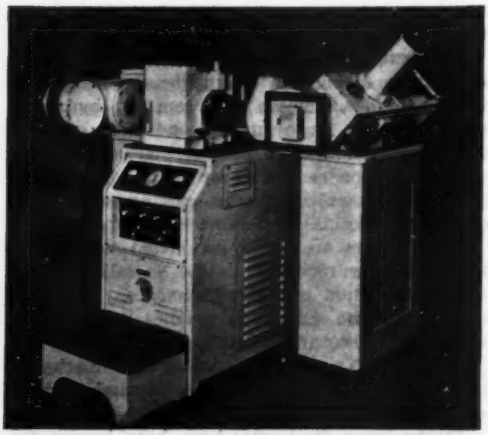
In all cases a strong magnetic field is produced around the plasma cord which compresses the plasma. Where the currents are large, the electromagnetic pressure may reach thousands of atmospheres.

We cannot expect to see regular thermonuclear reactors manufactured in the next few years, but there can be no doubt that the problem will be eventually solved. It will be possible to use thermonuclear reactions only on a large scale, in large power installations. Dreams of nuclear-powered motor cars or motor cycles will evidently remain dreams. Nuclear energy will be transmitted and distributed by means of electric power, and the development of thermonuclear energetics will make for still greater flowering of electric power engineering and for more extensive electrification.

OPTO-PHYSICAL MEASURING INSTRUMENT MADE BY VEB CARL ZEISS JENA FOR CHEMICAL INDUSTRIES

DR. W. NEBE, *Jena*

CHEMISTS in large industries, same as in laboratories, are continuously in search for methods by which to carry out analyses within the shortest possible time. Optical methods have come into the foreground and have been adopted for this purpose to a vast extent during the last 20 years. To the "classical"



methods of refractometry, interferometry, polarimetry as well as of photometry and of the spectral analyses, new provinces have been added, especially such as the expansion of the spectral analysis of the visible and ultraviolet regions to the infrared region of the spectrum and the employment of photoelectric measuring methods in the province of photometry. For all these methods, modern types of instruments have been developed by VEB Carl Zeiss JENA and have become indispensable expedients for analytical chemistry.

In the province of the micro-molecular chemistry, schlieren-optical and interference methods are of late being introduced in conjunction with electrophoretical and diffusion tests. For the observation and photographical recording the Macro-Electrophoresis Instrument (Fig. 1) is equipped with the universally applicable Schlieren-Recording Instrument 80. In addition to the registration of interference curves as well as of the gradients of the refractive index, etc., in stratified media, this schlieren equipment is also available for the examination of currents, heat-conductivity, ultrasonics and mixing processes, etc., in gases and liquids, as well as for testing the homogeneity of glasses. By employing the Toepler Schlieren Method it will be possible in this case to perceive deviations of light up to 2 sec. The specific request for Schlieren Apparatus for aero-dynamical and other examinations led to the development of a *Schlieren-Recording Apparatus with a 300 mm. diameter of the object field.*

THE END OF A WAVE

R. PRASADA RAO AND E. C. LAFOND

INTRODUCTION

NUMEROUS beach erosion studies have been conducted by the students and teachers of Andhra University, Waltair, India, during recent years. The level, movement, texture, and composition of the sands have been investigated, as have the oceanographic factors that control the beaches, namely, tides, currents, and waves.[1–4] Of these factors, the waves exert the major influence in beach erosion. Waves in the sea are formed by strong winds. When once developed, they travel great distances as swell from the storm area. As they approach a sand beach they break due to the shallowing of the water and the receding water of previous waves. Some waves expend their energy in the surf zone. Most, however, end by rushing up the beach and then receding down its slope. This paper presents some findings of the nature of waves during such final periods of swash and backwash.

SWASH AND BACKWASH PERIODS

Observations of a great many waves on different types of beaches show that average time between swashes is related to both the average time between breaking waves and the slope of the beach. On steep sloping sections of the beach the wave period is nearly as long as the swash period. However, the swash period far exceeds the breaker period on gently sloping beaches (Table I) because of the greater volume of water and slower movement of the backwash (and swash), and because there is less loss of water by percolation. This backwash overrides and neutralizes some of the advancing waves.[5]

TABLE I

Beach Slope (Degrees)	Swash Period (Sec.)	Breaker Period (Sec.)	Difference Swash − Backwash (Sec.)
2·1	30·0	14·5	15·5
2·3	23·8	14·2	9·6
3·2	22·1	14·2	7·9
4·0	19·4	13·2	6·2
6·0	16·3	13·7	2·6
7·4	14·3	12·8	1·5
8·3	14·8	13·9	0·9
10·5	12·1	11·4	0·7
12·1	11·7	11·6	0·1

SWASH AND BACKWASH SPEEDS

To measure the speeds of the swash and backwash a simplified manometer type flow meter was developed (see Fig. 1). It consists of two right angle glass tubes mounted on a frame. One open end of a right-angled glass tube was held towards the advancing water in the swash and the other towards the backwash. The height to which the water rose in the vertical portion of the tube over that of the surrounding water, provided a measure of the water speed.

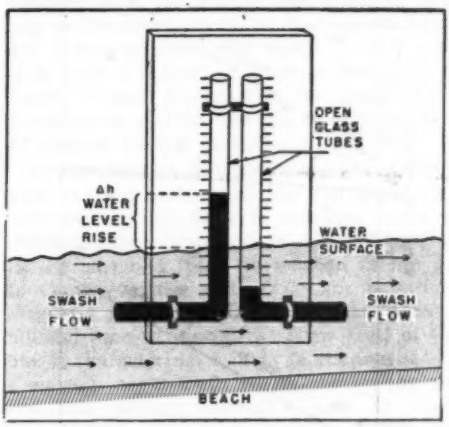


FIG. 1. Manometer type flow meter used to determine speed of swash and backwash.

Disregarding the frictional and orifice loss, the height that the water rises in the tube is

$$\Delta h = \frac{U^2}{2g}, \qquad (1)$$

where U is the velocity of the water and g is the acceleration of gravity.

Although considerable difficulty was encountered in holding the flow meter in an advancing wave, some variable though significant results were obtained (see Fig. 2). It was established that the maximum speed of the swash varied between different waves and with the depth at which the readings were taken. Consequently several repeated readings were required on each beach examined. The maximum speed of the swash was always found to be greater than the backwash. It was generally greater on a steep beach than on gentle beaches. Likewise the difference in maximum speeds, swash *minus* backwash, was greater for the steeper beaches. The least square empirical relation between the slope of the beach, ϕ, and the difference in speeds is

$$\phi_{9-10^\circ} = 0{\cdot}43 + 0{\cdot}14\,(U_s - U_b) \qquad (2)$$

where ϕ is in degrees and U_s and U_b are in cm./sec.

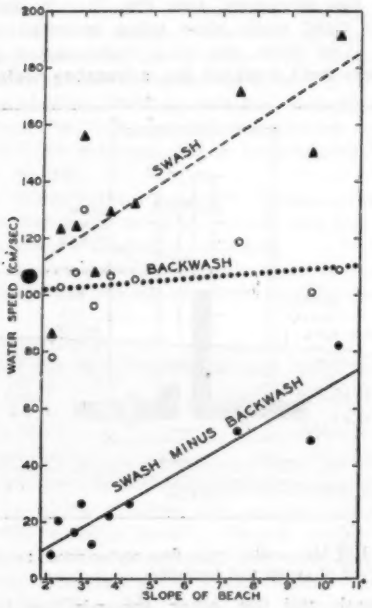


FIG. 2. Observed maximum speed of swash, backwash, and difference in speed (swash *minus* backwash) on beaches of various slopes.

Beach Erosion

According to Hjulström[6] the speed of flow required to transport sand depends upon the size of the grains. His graph shows

$$U \geq 7{\cdot}5d \qquad (3)$$

where d is diameter of sand grains in mm. and U is water speed in cm./sec. This means that a medium-size grain of 0·3 mm. diameter requires only a speed of 2 cm./sec. for transportation.

Since the maximum speed of the water even on gentle beaches is greater than 2 cm./sec., sand is continually moved by both the swash and backwash. At any instant the transport on and off shore will depend upon the slope of the beach and the speeds of the swash and backwash. To transport sand up the beach with a slope ϕ

$$U_s \geq 7{\cdot}5d + a \sin \phi \qquad (4)$$

and

$$U_b \geq U_s - 2\,a \sin \phi \qquad (5)$$

To establish whether the shoreward or offshore transporting forces predominate requires knowledge of the transporting ability of all water speeds on all sizes, shapes and compaction of sand grains. The forces must be integrated with respect to time. In addition, the difference in volume of water must be considered since some percolates into the sand and returns to the sea by a subsurface route.

Summary

These studies of waves, swash, and backwash have established that the wave period is less than the swash period. The difference between these periods increases inversely with the slope of the beaches. Also established is that the speed of the swash is greater than the backwash. The difference in speeds increases directly with the slope of the beach.

The dynamics of the end of a wave are seen to form a complex, though important, oceanographic problem, especially in the study of beach erosion and dissipation of wave energy.

Acknowledgements

The authors are grateful for the helpful suggestions of Professor C. Mahadevan, Head of the Geology Department, Andhra University. One of us (R. P. R.) is thankful to Mr. M. B. R. Rao, Director of Geophysics, Oil and Natural Gas Commission, for his interest in the work.

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2. —, *Andhra Univ. Memoirs in Oceang.*, 1954, **1**, 66-77.
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5. Emery, K. O. and Gale, J. F., *Trans. of Adm. Geoph. Union*, 1951, **32** (1), 31-36.
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NEW SUPERCONDUCTORS

IN the course of a detailed study of the superconducting behaviour of uranium alloys at temperatures 1-2° K., Dr. B. S. Chandrasekhar and Dr. J. K. Hulm, of the Westinghouse Research Laboratories, found for the first time four superconductors among the 'intermetallic compounds' of uranium. The compounds are formed when uranium is chemically combined with such metals as aluminium, manganese, cobalt, iron and nickel. Of special interest is the fact that two of them are the first superconducting compounds ever known to contain manganese and iron, two elements that always have been considered incompatible to the existence of superconductivity.

SEISMIC EXPLORATION FOR OIL IN THE CAMBAY AND NEIGHBOURING AREAS, BOMBAY STATE*

L. N. KAILASAM
Geological Survey of India

THE recent discovery of oil near Cambay as a result of the drilling operations at present being carried on by the Oil and Natural Gas Commission is a culmination of intensive and detailed geophysical investigations carried out in that area by the Geological Survey of India during the period 1948 to 1957, resulting in the location of the Lunej structure by reflection seismic exploration.

The geological features of the areas surrounding the alluvial tract of Gujarat and Eastern Saurashtra are indicated in the sketch map

FIG. 1

1. Pleistocene & Recent. 2. Siwalik System Coastal Tertiary Deposits. 3. Tertiary (Eocene). 4. Deccan Trap. 5. Cretaceous. 6. Jurassic Upper Gondwanas of the Peninsula. 7. Dharwarian. 8. Granites & Gneisses.

shown in Fig. 1, which is based on the geological map of India, published by the Geological Survey of India. On the west, the alluvial tract is bounded by Deccan Trap of the Kathiawar Peninsula and the Jurassic sandstones of North-Eastern Kathiawar and Kutch. Several exposures of trap rock occur on the eastern flank of this alluvial tract, but the major part of these exposures comprises rocks of the Aravalli system and crystalline gneisses. Outcrops of tertiary sediments can be seen on either side of the Gulf of Cambay. This fact coupled with the known occurrence of natural gas in the Gogha area on the eastern coast of the Kathiawar Peninsula, encountered in a borehole sunk to a depth of 1,016' in 1930 for ground water, formed the basis of the geophysical investigations carried out in this area by the Geological Survey of India.

Reconnaissance magnetic surveys were carried out by S. L. Banerjee and party during 1948-49 over the Gujerat alluvium in an area extending from Wadhwan in the west to Godhra in the east and from Ahmedabad in the north to Cambay in the south. On the basis of the magnetic anomalies, Banerjee inferred that the alluvial area to the north of the Gulf of Cambay is characterised by two faults disposed with a roughly north-south trend, one on the western side passing through Gundi in Eastern Saurashtra and another along the Mahe River in the east. He further postulated the thickness of the sediments to be maximum in the Cambay area, being of the order of 10,000-12,000' due to the down-faulting of the basement rocks.

Further detailed gravity and magnetic surveys were carried out by B. S. Negi and party during the field seasons 1951-52 and 1952-53 over the region extending from the Mahe River in the east to the west of the Sabarmati River and from Anand to the Gulf of Cambay in the north-south direction. Some strong regional as well local gravity and magnetic anomalies were outlined as a result of these surveys, including a prominent gravity-*cum*-magnetic anomaly in the area to the north and west of Cambay town.

The gravity and magnetic anomalies outlined by Negi were taken up for detailed reflection seismic investigations by a geophysical party led by the author and assisted by R. S. Chellam and others during the field season 1956-57.

A prominent buried structural 'high' was indicated in the Paldi area by the seismic data, confirming thus the gravity and magnetic anomalies observed earlier. This structure in the Paldi-Lunej area was located and partly outlined in the season 1955-56 and the seismic mapping of this structure was continued and completed during the 1956-57 season.

*Published with the kind permission of the Director, Geological Survey of India.

A typical seismogram from the Cambay area is reproduced in reduced form in Fig. 2. As can be seen, a number of reflections are brought out in the records. Of these, five are consistent and well defined, having associated

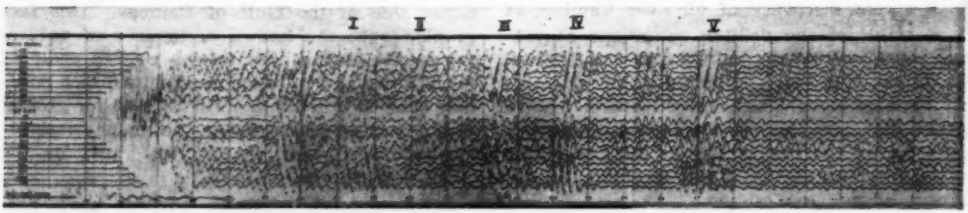

FIG. 2

two-way times of the order of 0·73, 0·90, 1·18, 1·40 and 1·78 seconds respectively. These are designated as reflections I to V. The last of these reflections is characterised by particularly strong intensity. This reflection which should be arising from a compact, strongly reflecting horizon is of special interest inasmuch as it may represent the top of the Deccan Trap, in which case the potentialities of the area for the occurrence of petroleum are considerably enhanced. The seismic observations were therefore extended along two long traverses, one from Cambay to Dholera in the west (see Fig. 1) where trap rock had been encountered at a depth of about 1,100′ in a borehole drilled for water, and the other eastward from Cambay connecting up with the trap rocks occurring to the east of the Mahe River. Although the reflection obtained from the trap surface at the borehole near Dholera does not have the same characteristic intensity as reflection V in the Cambay area, the latter could be followed across the Sabarmati River—where no shooting was possible for a stretch of two to three miles on the traverse—upto the Dholera borehole. While the seismic results do not provide any evidence of a major fault occurring on the western side of the Gulf of Cambay, the data indicates that the horizon identified with the trap surface at the Dholera borehole regularly and continually slopes eastwards across the Sabarmati River through what appears like a series of minor step faults. From Cambay to the east, the same horizon regularly and progressively slopes upwards up to the trap exposures occurring to the east of the Mahe River without having undergone any faulting. The Gujerat alluvium to the north of the Gulf of Cambay is thus characterised by a broad, synclinal basin lying roughly within longitudes 70° 15′ E. and 73° 10′ E. across the Sabarmati and Mahe Rivers, the maximum thickness of the sediments occurring approximately in the region between longitudes 72° 28′ E. and 72° 48′ E. including Cambay and the adjacent areas to the north. The seismic data further indicates a depth of the order of 1,500′ for the thickness of the alluvium in the Cambay area.

The structure in the Paldi-Lunej area was mapped by detailed seismic shooting carried out over several traverses in the area. Phantom horizons have been drawn for three of the well defined reflections II, IV and V mentioned earlier with two-way times of the order of 0·90, 1·40 and 1·80 seconds corresponding to depths of the order of 3,000, 5,100 and 7,000′ respectively. Contour maps drawn for these phantom horizons for the reflections II, IV and V indicate a closed structure for both the horizons IV and V. In Fig. 3 is shown the contour map

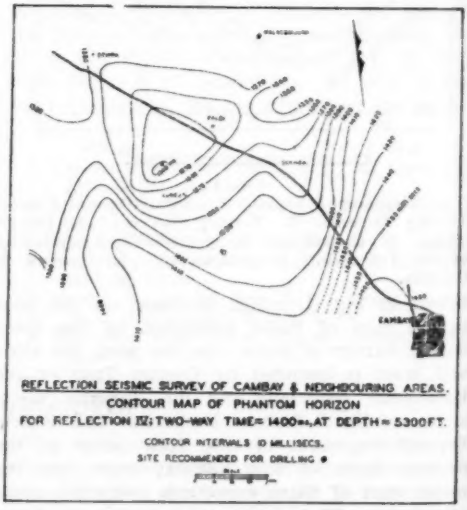
REFLECTION SEISMIC SURVEY OF CAMBAY & NEIGHBOURING AREAS.
CONTOUR MAP OF PHANTOM HORIZON
FOR REFLECTION IV; TWO-WAY TIME= 1400 m.sec. AT DEPTH = 5300 FT.
CONTOUR INTERVALS 10 MILLISECS.
SITE RECOMMENDED FOR DRILLING

FIG. 3

for horizon IV. It may be seen that the closed structure near Lunej is clearly brought out. The site recommended for test drilling is also indicated therein. It may be mentioned here that

oil has also been struck, as reported, at a depth of 1,600 metres, closely corresponding to this horizon.

Inasmuch as the Lunej structure has now proved oil, it will be advantageous to extend the seismic investigations to the neighbouring areas to the north and west of Cambay where additional gravity and magnetic anomalies have been noted.

Thanks are due to all the colleagues of the author who participated in these surveys and to Shri M. B. Ramachandra Rao for valuable suggestions.

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TESTING AND STANDARDISATION OF FOUNDRY MATERIALS*

CONSISTENCY in the quality of castings produced by a foundry depends greatly upon the control of the quality of a number of complex raw materials—sands, binding materials like bentonite, core oils and resins, fuel, air, metals, master alloys, fluxes, pattern materials, etc., used under severe conditions of temperature and erosion. An evaluation of their actual performance in relation to their fundamental properties will be of immense use to the foundry engineers.

According to Dr. Zang, three important criteria could be used to test bentonites for steel foundry use. To indicate that the sample has sodium as the main exchangeable ion, which gives high green strength to moulding sands, the pH should not be less than 8·2 and the calcium oxide content should not be more than 0·70%. Being a layer type of mineral, bentonite progressively increases in plasticity with increase in water content, till at a certain proportion of water to dry clay substance—known as the liquid limit—there is an abrupt increase in plasticity. The liquid limit for bentonites for steel foundry use should not be less than 525.

The mechanism of heat transfer in sand moulds is discussed. By a proper choice of materials and of disposition of mould masses, the rate of heat dissipation from the liquid metal can be so regulated as to obtain higher and more uniform mechanical properties of the resultant casting. This paper also discusses the use of metal moulds and points out the advantage of anodized aluminium as metal mould because of its heat transfer characteristics. Zircon sands also offer interesting possibilities.

Radiographs of sand compacted into a standard V-notch show that the mobility of sand grains adjacent to the pattern surface is governed by friction and by pattern contour. Higher packing density is obtained when such friction is reduced either by using a dry lubricant like talc or by vibration.

Magnesium contents of less than 0·1% in iron of suitable chemical composition bring about spherodization of graphite with revolutionary changes in its properties, particularly in ductility. Phosphorus is the principal element that precludes the suitability of Indian pig iron for the manufacture of spherodized graphite iron. Under Indian conditions, S. G. iron can be manufactured only by the use of a charge mostly of steel scrap and S. G. Foundry returns in electric melting furnaces.

* A scientific account of the Symposium on " Testing and Standardisation of Foundry Materials " held under the auspices of the Bangalore Chapter of the Indian Institute of Metals, at the Indian Institute of Science, Bangalore, on 9th and 10th October 1958.

OBITUARY—DR. K. C. PANDYA

WE regret to announce the death of Dr. K. C. Pandya, Retired Professor of Chemistry, Agra University, and a member of the Current Science Association. A Fellow of the Indian Academy of Sciences, he and his students contributed many papers to the *Proceedings of the Academy*. Dr. Pandya was mainly responsible for collecting and publishing in book form a series of radio talks on scientific subjects by Sir C. V. Raman. This book was later republished by the Philosophical Library of New York, and also by a publisher in Japan where it is used as a text for science students learning English.

LETTERS TO THE EDITOR

STRESS AND WAVELENGTH DEPENDENCE OF BIREFRINGENCE IN CUBIC CRYSTALS IN THE VISIBLE REGION

THE relation between stress and the stress-induced birefringence in cubic crystals has been studied by us in the wavelength range 4,800-6,000 Å employing for the purpose a modified form of Filon's Spectrometer Method described by us in an earlier paper[1] on some alkali halides.

We have now extended the method to the study of eight more cubic crystals given in Table I. It will be noticed that the present results agree with those of previous observers.[2]

nitrates of Table I, show a variation with wavelength of light. In general, they tend to decrease with increasing wavelength. However, in thallium alum and potassium iodide q_{44} and $(q_{11} - q_{12})$ respectively show an increase. The behaviour of KI in this respect is similar to what has been observed in KCl and KBr. The potassium ion is common to all the three crystals and the systematic differences noted in Table II arise with the change of the negative ion.

$(q_{11} - q_{12})$ and its dispersion (the ratio of total change in $q_{11} - q_{12}$, over the range of wavelengths studied, to its value at the mean wavelength) steadily increase as the negative ion changes from Cl through Br to I. The opposite effect is observed in q_{44}.

TABLE I

Crystal	$(q_{11}-q_{12})\times 10^{13}$ c.g.s.	Dispersion %	$(q_{11}-q_{13})\times 10^{13}$ c.g.s.	Dispersion %	$q_{44}\times 10^{13}$ c.g.s.	Dispersion %
KI ..	+ 1·846	19·7	..	..	−3·042	1·7
LiF ..	− 1·410	6·6	..	..	−0·728	27·3
CaF_2 ..	− 1·478	2·0	..	..	+0·810	3·7
K-Alum ..	− 5·225	4·6	− 4·660	4·3	−0·696	14·9
NH_4-Alum ..	− 5·325	10·3	− 4·575	6·8	−1·194	18·3
$Ba(NO_3)_2$ ..	−22·88	8·5	−17·16	8·3	−1·680	9·3
$Pb(NO_3)_2$ ..	−18·88	15·5	−10·96	3·6	−1·292	4·7
Thallium Alum ..	..	..	..	..	+0·808	30·2

The relative retardation occurring in unit thickness of the crystal has been measured for stresses ranging from 0 to 50 kg. per sq. cm. at several wavelengths of light. Owing to the fragile nature of some of the crystals, particularly the alums, it is not possible to increase the stress much further. The plots of retardation *versus* stress for every one of the crystals are strictly linear when the stress applied is in the direction [001] and the directions of observation are either [010] or [100]. This linearity also obtains for stresses in the direction [111] and observation along [211]. As in the case of alkali halides studied earlier,[1] all crystals show a small residual birefringence of the tensional kind.

The quantities $(q_{11} - q_{12})$ and q_{44} which describe the stress optical behaviour of KI, LiF and CaF_2 and the additional quantity $(q_{11} - q_{13})$ which characterises the alums and

TABLE II

Crystal	$(q_{11}-q_{12})\times 10^{13}$ $\lambda = 5890$ Å	Dispersion %	$q_{44}\times 10^{13}$ $\lambda = 5890$ Å	Dispersion %
KCl ..	+1·47	7·8	−4·94	4·6
KBr ..	+1·76	12·0	−4·42	2·3
KI ..	+1·84	19·7	−3·04	1·7

The crystals NaCl, LiF, K and NH_4 alums, Ba and Pb nitrates in which the signs of both $(q_{11} - q_{12})$, and q_{44} are negative, belong to group II of Pockel's classification. The dispersions in them are found to be similar—all of them showing a decrease with increasing wavelength and the magnitude of the dispersion, given in Table I as a percentage, is usually higher in q_{44} than in $(q_{11} - q_{12})$ or $(q_{11} - q_{13})$.

The crystals of Table II fall under Group IV of Pockel's classification showing a greater dispersion in $q_{11} - q_{12}$ than in q_{44}.

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ETCHING OF FLUORITE

EXPERIMENTS on etching of crystal surfaces have been reported in recent years.[1-4] We report here some interesting results obtained in the case of fluorspar in our Laboratory.

The two (111) faces obtained on cleaving a crystal of fluorite by means of a sharp blow with a pointed edge, were etched by sulphuric acid at room temperature for different times. The etched surfaces were then coated with highly reflecting silver films and examined under a microscope. It is observed that in the initial stages, there is general etching with scattered triangular etch pits. As the etching period is increased, etch pits resembling the familiar block pattern, as reported in the case of diamond, appeared at some places. The more scattered triangular etch pits were found to be randomly distributed but oriented in definite directions and to have point-to-point correspondence in the two faces. These pits may be due to inclusions or other types of imperfections such as dislocations. The detailed results will be published elsewhere.

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A NOTE ON CONDUCTOMETRIC STUDIES ON COPPER TUNGSTATES

THERE is hardly any reference in literature to the study of the reaction between $CuSO_4$ and Na_2WO_4 by physico-chemical methods.

Standard solutions of A.R. quality reagents Na_2WO_4 and $CuSO_4$ were prepared in conductivity water and used in the present work. The conductivities were measured by Kohlrausch Universal Bridge (W. G. Pye, Ltd.), keeping the titration cell immersed in a thermostat maintained at $30 \pm 1°$ C. The conductance obtained after each dilution was corrected for dilution effect.[1] Using different concentrations of the reactants, the titrations were performed both by direct and reverse methods, in aqueous and aqueous alcoholic media. The pH of the solutions was measured with a glass electrode.

From conductometric curves (Fig. 1), it may

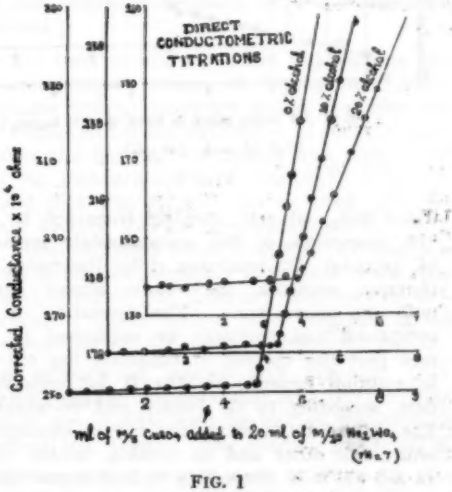

FIG. 1

be observed that a sharp break is obtained at a point which corresponds to the formation and precipitation of normal Na_2WO_4 at pH 6·0-6·5. When $CuSO_4$ is added to Na_2WO_4, there seems to be no change in conductivity as the mobility of SO_4^{--} ion is nearly of the same order as that of WO_4^- ion, but when the end-point is reached, a slight excess of $CuSO_4$ increases the conductivity. The results of chemical analysis agree with the above compound. Reverse titrations give satisfactory results (with an obtuse angle between the intersecting lines) in uniformity with those obtained by direct methods.

Definite amounts of acid HNO_3 were added to Na_2WO_4 solution and again conductometric titrations were performed. Fig. 2 reveals that

a break in the curve is obtained at a point where the molecular ratio of the reactants $CuSO_4$ and Na_2WO_4 is as 1 : 4, corresponding to the formation of copper metatungstate

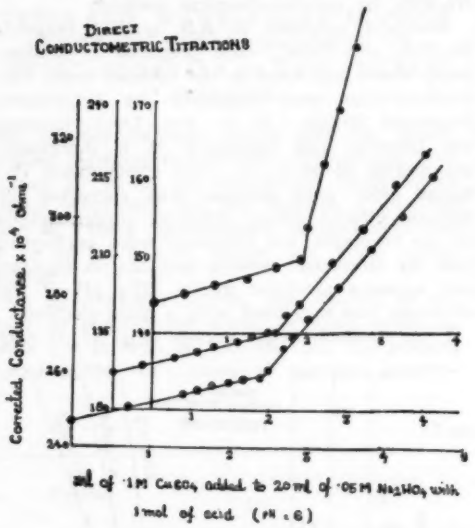
DIRECT
CONDUCTOMETRIC TITRATIONS
Corrected Conductance, x 10⁻⁶ ohms⁻¹
ml of 1M CuSO4 added to 20 ml of 05M Na2WO4 with
1 mol of acid (pH 6)

FIG. 2

$CuO.4WO_3$, at pH ranging from 4·8 to 5·2. The precipitate of this metatungstate seems to be colloidal. On analysing it for the metal and tungsten contents, the results almost agreed with the above ones. The formation of this compound can probably be explained by the fact that the species of tungstate ion existing in solution depends on the H ion concentration, according to G. Jander and co-workers.[2] The different tungstate ions are in equilibrium with each other and in *weakly* acidic range (4·8-5·5), it is interesting to find copper metatungstate $CuO.4WO_3$, precipitating. This is further supported by the fact that metatungstates have a *weakly* acidic reaction.[3] No precipitate of copper tungstate is obtained in the acidic range beyond 4·8.

The role of alcohol is to decrease the solubility of copper tungstate in water, and hence a closer approach to theoretical titre values is obtained when the titrations were carried in aqueous alcoholic media.

The determination of solubility products of various copper tungstates is in progress and the results would be communicated later.

Grateful thanks are due to Dr. S. Ghosh, Head of the Department of Chemistry, University of Allahabad, Allahabad, for kindly introducing us the subject of study.

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KINETIC STUDIES IN CHROMIC ACID OXIDATIONS

As part of the programme on the role of solvent in chemical reactions, the oxidation of secondary alcohols by chromic acid under controlled conditions was taken up. Waters,[1] Westheimer[2a,b] and Kuivila and Becker[3] have reported on the mechanism of the reaction under other conditions and found the reaction to be of the first order with reference to the alcohol as well as the chromic acid used in their studies. Our present observations with isopropyl alcohol as well as with cyclohexanol confirm the reaction order using acetic acid as the solvent medium.

As one of the reactants is an ionic one, the reaction should show clearly the influence of ionic environment. The change in ionic strength

TABLE I

Concentration of alcohol: 0·45145 M
Concentration of chromic acid: 0·00669 M
Concentration of potassium acetate: 0·2 M

% of acetic acid (by vol.) in the acetic acid–water mixtures	Isopropyl alcohol—Second order rate const. × 10^5			Cyclohexanol—Second order rate const. × 10^5		
	35° C.	40° C.	45° C.	35° C.	40° C.	45° C.
30	0·676	0·9822	1·249	2·397	2·628	2·774
40	1·387	2·0510	2·63	3·849	5·354	5·759
50	2·834	3·784	5·685	5·751	8·153	9·867
60	5·880	9·268	10·29	11·605	16·87	20·16
70	13·58	19·03	27·03	31·07	40·597	49·87

in the course of the reaction was noticeable in the pronounced trend in the rate constants and this was avoided by the initial addition of adequate quantities of pure potassium acetate. This incidentally helped in keeping the hydrogen ion concentration constant. Under these controlled conditions, the reaction was followed by iodometric estimation of the unreacted chromic acid. A summary of the observations is presented in Table I.

The plot of log k_2 against the reciprocal of the absolute temperature shows a clear linearity but the Arrhenius activation energies obtained are abnormally low, being of the order of 2·5 k.cals. The complex nature of the reaction is obvious. The frequency factor appears however to be less abnormal, though the value of 10^{10} is still rather low. Though acetic acid and water do not form ideal mixtures, within the range of composition studied, the dielectric constant changes may be expected to show approximate linear behaviour. This may be expected to be reflected in the reaction rate. The log k_2-composition curves (Fig. 1) with both alcohols bring this out. The slopes of the curves in the case of cyclohexanol suggest that for an initial small addition of acetic acid, the temperature coefficient will be negligible, confirming further the complexity of the reaction.

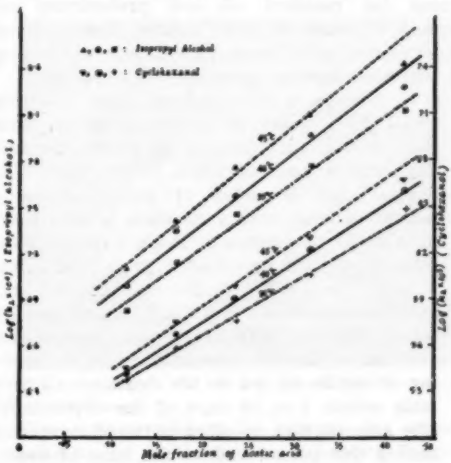

FIG. 1

Fuller details will be published elsewhere.

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STANDARD RESACETOPHENONE OXIME IN SPECTROPHOTOMETRY

[ABSTRACT.—*In the present communication a simple method is described for standardising a solution of Resacetophenone oxime in aqueous alcohol. A known amount of resacetophenone oxime solution is added to a known excess of a solution containing copper. The precipitate of Cu-Rapox filtered off and the excess of copper in the filtrate determined by the thiosulphate method.*]

IT has been shown in earlier publications that resacetophenone oxime (2, 4-dihydroxy acetophenone oxime) hereafter styled as *Rapox* can be employed for the estimation of nickel,[1] separation and detection of copper and nickel[2] and for the standardisation of cyanide.[3] It is now found that this reagent can be used with the same facility for the spectrophotometric study of iron[4] and such other elements. During this study it became necessary to prepare a standard *Rapox* solution for different colorimetric estimations. These efforts have resulted in the development of the method described herein.

A solution of copper was prepared from Merck's copper sulphate that was recrystallised and it was standardised by sodium thiosulphate method (*c.f.* Vogel[5]). The solution was 0·592 M.

Rapox was prepared and purified by the method described by Bhatki and Kabadi.[2] A weighed amount of the reagent was then dissolved in 40% ethanol and made to a known volume. This solution was standardised according to the procedure given below for use in the spectrophotometric studies. Potassium iodide, sodium thiosulphate and all the other reagents utilised during the experiment were of Merck's extra pure quality.

A known excess of copper solution was pipetted out in a beaker, neutralised with sodium carbonate and dilute acetic acid added till the solution was clear. The solution was then adequately diluted and a known volume of *Rapox* solution was introduced drop by drop

TABLE

Amount of *Rapox* taken, mg.	N/20 $Na_2S_2O_3$ required for excess Cu, ml.	N/20 $Na_2S_2O_3$ corresponding to Cu, used up, ml.	Amount of *Rapox* found from the amount of Cu, used up, mg.	Weight of Copper-rapoximate mg.	Weight of *Rapox* found, mg.
250·7	281·0	15·0	250·7	297·0	250·8
334·3	275·9	20·1	335·9	393·5	332·3
417·9	270·9	25·1	419·5	493·0	416·3
501·4	266·1	29·9	499·7	590·0	498·3
668·6	255·8	40·2	671·9	787·5	665·1

with constant stirring. After copper-rapoximate was completely precipitated, the beaker was allowed to stand for some time and the solution later filtered through a sintered glass crucible (porosity 2 G 4). The precipitate was washed several times with cold distilled-water. The filtrate and the washings were collected and made to a known volume in a measuring flask after the addition of a few c.c. of dilute H_2SO_4. A measured volume was then withdrawn and titrated against standard solution of sodium thiosulphate as usual. Blank titrations were also carried out with the copper solution. The precipitate of copper-rapoximate which was collected in each experiment in the sintered glass crucible was dried at 120° C. to constant weight. This was done to confirm the results obtained by the present method. The results are given in the Table.

Two of the authors (K. S. B. and A. T. R.) are obliged to Dr. B. V. Thosar of T.I.F.R. for his encouragement by way of the facilities that he gave during the progress of the work.

The Institute of Science and The Tata Institute of Fundamental Research, Bombay-1, *June* 3, 1958.

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TOXICITY OF WHITE OIL

INVESTIGATIONS in the past few years have revealed that the epidemiology of epidemic dropsy appears to be related to the use of adulterated edible oils, especially mustard oil. Various views have been expressed as to the nature of the compounds present in adulterants, and supposed to be specifically responsible for the characteristic lesions of epidemic dropsy. Argemone oil from the seeds of *Argemone mexicana* is said to be a very common adulterant of commercial mustard oil. Sarkar[1] isolated an alkaloid sanguinarine from argemone oil, and the proved toxic properties of the oil have been attributed to the presence of this alkaloid. Sen[2] reported the presence of mineral oils as adulterants in mustard oil, and directed attention to their toxicity. In particular, white oil, a cheap mineral oil, was found to be widely used as an adulterant for mustard oil and preliminary reports[3,4] indicated its toxic nature. Some animal experiments undertaken to evaluate the effects of white oil feeding gave following results:

1. Groups of mice and rats were fed with small daily doses of white oil mixed with their normal diet (0·5 c.c. of white oil/mice/day; and 1·0 c.c. of white oil/rat/day). The normal diet consisted of pieces of bread soaked in fresh milk containing a little marmite and a few drops of shark liver oil, supplemented with germinated gram and sweet potatoes. In 3 to 5 days, the experimental animals developed a condition characterised by rough dry skin with erect hairs, restlessness and loss of weight. Continuation of the feeding of white oil led to the death of all animals within 7 to 10 days of the experiment. The animals had no other outward symptoms during this period and at the time of death. The animals of the control group, fed with the same basal diet containing equivalent amounts of pure mustard oil, were free from all symptoms. Fig. 1 shows the conditions of one pair of experimental rats on the fourth day of the experiment; a pair of the control group on the same date are shown in Fig. 2 for comparison.

2. Preliminary histopathological examination of the organs of the experimental animals, after death, revealed diffuse fatty degeneration of the parenchymatous cells of the livers, proliferation of the reticulo-endo-

thelial cells of the splenic pulp, marked hypertropy and hyperkeratosis of the epidermis together with cellular infiltration of the corium and degenerative changes in the ascending tubules of the kidneys. Further work is in progress.

FIG. 1. Rats, on the 4th day of feeding with white oil.

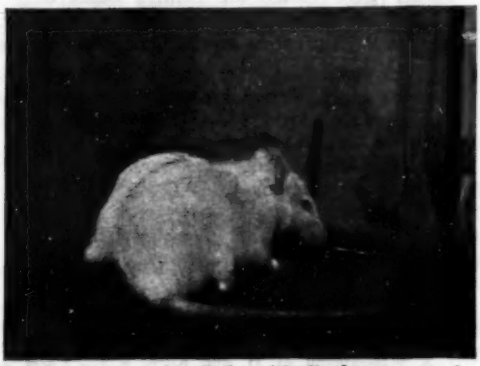

FIG. 2. Rats, on the 4th day of feeding pure mustard oil (Control).

The author wishes to express his sincere thanks to Dr. A. Mukherjee, School of Tropical Medicine, Calcutta, for his help in the histological work.

Biochem. Section, H. D. BRAHMACHARI.
Birla College of Science,
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STUDIES IN THE REACTIONS OF α-KETO ACIDS

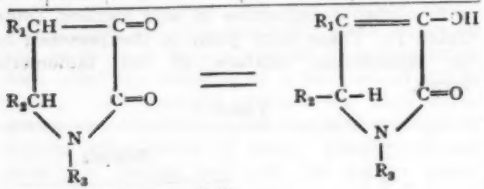
IN view of the large amount of experimental evidence published recently[1-3] on the chemistry of 2 : 3 pyrrolidinediones, we wish to make a preliminary report on the preparation of some of these diones and their chemical reactions. These diones were prepared by the condensation of phenyl- and 3 : 4 dimethoxyphenylpyruvic acids with aldehydes and amines in alcoholic solution. All of these compounds gave a blue to green colouration with alcoholic ferric chloride indicating the presence of an enolic hydroxyl group. They formed acetyl derivatives on heating with acetic anhydride and pyridine and at the same time furnished crystalline quinoxaline derivatives by condensation with *o*-phenylenediamine in acid solution (*vide* Table I). These facts point to the presence of an equilibrium mixture of the tautomeric forms.

TABLE I

No.	m.p. of pyrrolidinedione	Formula	Analysis			
			Found		Calculated	
			C%	H%	C%	H%
1	248°	$C_{22}H_{17}O_2N$	80·2	5·0	80·73	5·19
2	256°	$C_{24}H_{21}O_3N$	77·4	5·7	77·63	5·6
3	196°	$C_{23}H_{18}O_5N_2$	69·1	4·2	68·7	4·47
4	237° (*d*)	$C_{24}H_{19}O_4N$	74·7	5·2	74·8	4·9
5	221°	$C_{24}H_{21}O_3N$	77·6	5·7	77·62	5·66
6	178°	$C_{25}H_{23}O_4N$	74·6	5·9	74·81	5·73
7	205°	$C_{26}H_{24}O_5N$	72·56	6·08	73·56	5·5
8	224° (*d*)	$C_{25}H_{20}O_6N_2$	65·2	4·2	64·9	4·32

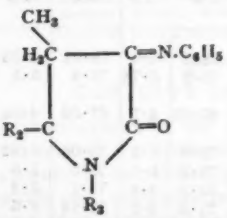
No.	m.p. of acetyl derivative	Formula	Analysis			
			Found		Calculated	
			C%	H%	C%	H%
1	184°·5	$C_{24}H_{19}O_4N$	78·5	5·0	78·01	5·19
2	218° (*d*)	$C_{26}H_{23}O_4N$	75·8	5·78	75·5	5·5
3	225° (*d*)	$C_{25}H_{20}O_6N_2$	67·55	4·5	67·56	4·54
4	207°	$C_{26}H_{21}O_5N$	72·9	5·1	73·06	4·92
6	165°	$C_{26}H_{23}O_4N$	75·9	5·6	75·5	5·5
6	155°	$C_{27}H_{25}O_5N$	73·0	5·6	73·1	5·8
7	197°	$C_{28}H_{26}O_6N$	71·5	6·1	71·14	5·5
8	219°	$C_{27}H_{22}O_9N_2$	62·8	4·3	62·5	4·2

No.	m.p. of quinoxaline	Formula	Analysis			
			Found		Calculated	
			C%	H%	C%	H%
1	252°	$C_{28}H_{21}N_3$	84·3	5·2	84·2	5·4
2	210°	$C_{30}H_{25}ON_3$	80·9	5·8	81·24	5·7
3	315°	$C_{29}H_{22}O_3N_4$	73·2	4·5	73·4	4·6
4	219°	$C_{30}H_{23}O_2N_3$	78·6	5·2	78·7	5·03
5	235°	$C_{30}H_{25}ON_3$	81·2	5·7	81·24	5·7
6	157°	$C_{31}H_{27}O_2N_3$	78·6	6·0	78·64	5·7
7	193°	$C_{32}H_{25}O_3N_3$	76·0	5·6	76·3	5·8
8	270° (*d*)	$C_{31}H_{24}O_6N_4$	83·2	5·1	83·03	5·3



1. $R_1=R_2=R_3=C_6H_5$
2. $R_1=C_6H_5$; $R_2=C_6H_4.OCH_3$ (*o*); $R_3=C_6H_4.CH_3$ (*p*).
3. $R_1=C_6H_5$; $R_2=C_6H_4.OCH_3$ (*p*); $R_3=C_6H_4.NO_2$ (*m*).
4. $R_1=C_6H_5$; $R_2=C_6H_3.O.CH_2.O$ (*m*, *p*); $R_3=C_6H_4.CH_3$ (*m*).
5. $R_1=C_6H_5$; $R_2=C_6H_4.OCH_3$ (*p*); $R_3=C_6H_4.CH_3$ (*p*).
6. $R_1=C_6H_5$; $R_2=C_6H_3.(OCH_3.)_2$ (*m*, *p*); $R_3=C_6H_4.CH_3$ (*p*).
7. $R_1=C_6H_3.(OCH_3)_2$ (*m*, *p*); $R_2=C_6H_4.OCH_3$ (*p*); $R_3=C_6H_4.CH_3$ (*p*).
8. $R_1=C_6H_3.(OCH_3)_2$ (*m*, *p*); $R_2=C_6H_3.O.CH_2.O$ (*m*, *p*); $R_3=C_6H_4.NO_2$ (*p*).

When α-keto butyric acid was condensed with benzaldehyde and aniline in acetic acid solution at 0° C. the product obtained was a mixture which after repeated crystallisations gave a low yield of a compound of m.p. 223° C., which from the analysis results was identified as the 'anil' of the following structure. It did not give any colouration with ferric chloride solution.



$R_1=R_3=C_6H_5$

This is in agreement with the facts reported recently by Vaughan and Covey.[1] Condensation of α-keto butyric acid with benzaldehyde and *p*-toluidine gave two products of m.p. 193-95° C. and 175-77° C.

Further work on their structures is in progress.

The pyrolysis of compound (I) was carried out as described by Borsche,[4] but instead of the expected stilbene, only a colourless, crystalline compound of m.p. 336° C. was obtained. (Found : C, 84·4 ; H, 5·3 ; N, 4·6 ; $C_{21}H_{15}ON$ requires C, 84·8 ; H, 5·0 ; N, 4·7.) It formed an acetyl derivative of m.p. 151° C. The pyrolysis product was identified as 2 : 3-diphenyl-4-hydroxyquinoline. Vaughan and Covey[1] have also reported the formation of this compound.

The action of phenylhydrazine on the pyrrolidinediones was attempted, but in contrast to the observations made by Meyer and Vaughan,[2] who have obtained different compounds with 1,5-diphenyl-2,3-pyrrolidinedione, in our hands the original substance was recovered unchanged.

We also wish to report that with some aldehydes and amines the two keto acids mentioned earlier gave either the Schiff's bases only or cinchoninic acids. Further work on these compounds is in progress and will be reported elsewhere.

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Institute of Science,
Mayo Road, Bombay-1,
July 19, 1958.

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SOUTHERLY PITCHING ANTICLINE NEAR DODDAGUNI

During a recent survey of the southern extension of the Chitaldurg Schist Belt near Doddaguni (Long. 76° 46′ and Lat. 13° 19′), a number of outcrops of ferruginous quartzites were found folded into anticlines pitching southwards. This belt consists of micaceous quartzites, schists, ferruginous quartzites, etc.[1] Among these the ferruginous quartzites stand out prominently and they form a range of hillocks running nearly north-south.

The ferruginous quartzites of this range preserve a good number of minor folds. In Fig. 1

is shown one of the most prominent minor folds found on the southern slope of the hillock △ 2923. The figure shows the pitch of the fold

FIG. 1

towards south. There is a cross joint running perpendicular to the axis of the fold about which the outcrop has moved apart. The pitch of the fold was measured along the axial plane (strike) of the fold; it is 28° towards bearing 166°.

The pitch angle was also calculated by representing the trends of the limbs on a stereographic projection[2] (Fig. 2). The eastern limb

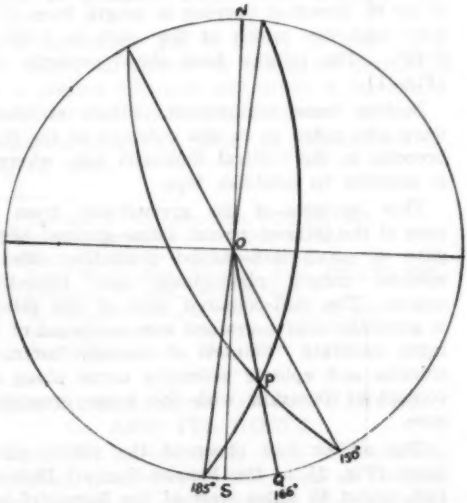

FIG. 2

strikes 150° and dips 58° and the western limb strikes 185° and dips 62°. Their stereographic traces intersect at the point 'P'. OPQ shows the trend of the axis of the fold 166° and PQ is the pitch which is 28°.

The same range of hillocks shows many minor folds. Due to pitching, the limbs of these folds converge and the beds 'wrap around'[3] the ends of the folds and die out forming 'noses'. The schists and micaceous quartzites also exhibit the same phenomenon. The 'noses' of all these formations show varying pitch from 12-46° in the same direction.

Very recently such a southerly pitching fold is reported from Satnur, Kanakapura Taluk, Bangalore District.[4]

Further studies of the region are in progress.

The author is grateful to Professor M. R. Srinivasa Rao, Department of Geology, Central College, Bangalore, for his valuable suggestions and guidance.

Dept. of Geology, K. M. GURAPPA.
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SOREL CEMENT AS A BINDER FOR POWDER FUEL WASTES

THE excellent cementing properties of Sorel Cement suggest its possible use as a binder for briquetting fuel wastes.[1,2] Experiments were carried out in this Institute to test its binding ability.

Powder wastes of coal and charcoal from the local market were ground and sieved. Figures for the sieve analysis of the powders used and the proximate analysis of the coal dust are given below:

Sieve analysis			Proximate analysis of coal dust	
B.S.S. mesh	Coal	Charcoal		
	%	%		%
− 14 + 18	11·5	10·5	Moisture	1·36
− 18 + 30	26·0	25·5	Ash content	31·00
− 30 + 60	26·5	24·0	Fixed carbon	49·22
− 60 + 100	15·0	18·0	Volatile matter	18·42
− 100 ..	21·0	22·0		

Low grade magnesium oxide (80% MgO) obtained by calcining Salem magnesite at 1,000° C. and crushed to − 170 B.S.S. mesh was used along with magnesium chloride solution of

No.	Property	Coal briquettes		Charcoal briquettes
		with 5% MgO	with 3% MgO	
1	Apparent Sp. Gr. ..	1·3	1·2	0·8–0·9
2	True Sp. Gr. ..	1·55	1·42	1·3
3	Porosity % calculated from $\left\{\frac{\text{Apparent Sp. Gr.}}{\text{True Sp. Gr.}}\right\}$ 100–100 ..	16·1	15·5	30·0–38·5
4	% by weight of water absorption after 48 hours soaking	6·0–7·0	6·0–7·0	8·2
5	Weathering index ..	1·4	4·3	4·8
6	Compressive strength (P.S.I.) after 21 days storage ..	190	80	95

density 20-21° Be', as binder. The fuel powder was first lubricated with 12-15% of its weight of magnesium oxide. This was followed by the addition of just enough magnesium chloride solution to make a good wet mix. The thoroughly mixed material was packed into rectangular wooden moulds: 3′ × 1½″ × 1½″. The bars were allowed to set for 18 hr., then removed from the moulds and cut into cubes of 1½″ side. The cubes were sun-dried for 2-3 days.

A summary of the physical properties of briquettes, tested according to A.S.T.M. standards,[3] is given below:

Briquettes made with 5% MgO were found to be superior. As evident from the compressive strength tests, they could withstand rough handling for transport. Further, when tested, they were found not to break or chip when dropped thrice on an iron plate from a height of 6′.

The briquettes burn well without losing shape.

The author wishes to express his thanks to Dr. A. N. Kappanna, Assistant Director-in-Charge, for suggesting the problem and permitting the publication of this note.

Central Salt Res. Inst., Bhavnagar, *June* 9, 1958. MOHAN RAI.

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PILLOW STRUCTURES IN THE RAMAGIRI SCHIST BELT, ANANTAPUR DISTRICT, ANDHRA PRADESH

PILLOW structures were observed by the author in the Ramagiri schist belt for the first time during the field-season 1957-58, while he was engaged in detailed structural mapping of the belt on 8″ to a mile scale with a view to assessing the economic potentialities of this abandoned gold field. Particular attention was paid to the structural and lithologic controls of gold mineralisation, wall rock alteration and mineral paragenesis.

The pillow structures were noted at:

1. Nineteenth milestone and south of 19/6 milestone on the Dharmavaram-Peruru Road. Here the pillows are stretched in a N. 15° E. to N. 40° E. direction varying in length from 0·6″ to 2′ 4″ and in breadth from 0·2″ to 0·6″. The thickness of the skin varies from 0·25″ to 0·5″;

2. West of 21/4 milestone and about 4 furlongs west of Jubitil mines. The pillow structures (Fig. 1) occur in the massive meta-basalts, which have occupied shear zones in these two localities, as was evidenced from the intense silicification and chertification of the outer skins of the pillows and crushing of the meta-basalts. The pillows are oblong and imperfectly bun-shaped and the outer skin in some cases is drag-folded. They are elongated in N. 10° W. direction varying in length from 1″ to 3′ 6″ and the width of the skin is 0·25″ to 0·75″. The pillows here show westerly tops (Fig. 1).

Besides these occurrences, pillow structures were also noted in *in situ* outcrops of the flow-breccias in the Central Ramagiri belt, where it is possible to establish tops.

Thin sections of the greenstones from the core of the pillows reveal a fine-grained aggregate of small lath-shaped actinolite, chlorite, epidote, minor plagioclases and interstitial quartz. The dull-coloured skin of the pillows is generally coarse-grained and composed of the same minerals. Veinlets of coarsely laminated chlorite and epidote generally occur along the contact of the skin with the inner greenstone core.

The author had observed the pillow structures (Fig. 2) in the Penner-Haggari Dharwar belt, about 50 miles west of the Ramagiri belt, during his mapping of the Bellary District. The skin of the pillows shows three distinct zones consisting of an outer cherty zone of about 0·6″ width, the central hornblendic zone of about 0·7″, and the inner amygdular one of 1″ thick

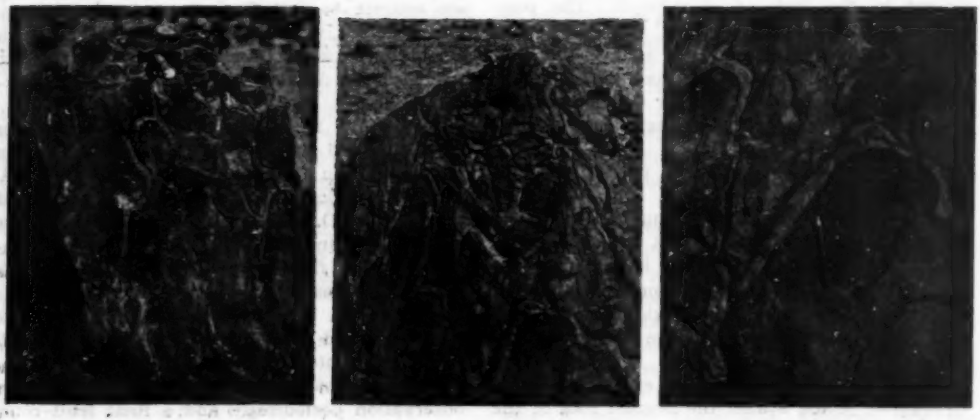

FIG. 1 FIG. 2 FIG. 3

FIG. 1. Pillow structures in the Ramagiri schist belt with westerly tops. (♂)
FIG. 2. Pillows from Penner–Haggari band with easterly tops. (♂)
FIG. 3. Zones in the outer skin of the pillows in the Penner-Haggari schist belt.
Zone 1 : Cherty; *Zone 2* : Hornblendic; *Zone 3* : Amygdular.

(Fig. 3). Here the pillows show easterly tops (?) while in the Ramagiri belt they top west.

The presence of the pillow structures in most of the Dharwar schist belts in South India (*i.e.*, Kolar, Ramagiri, Penner-Haggari, Sandur, Chitaldrug, etc.) is suggestive of the consanguity in their tectonic and igneous histories, and might be grouped under one 'Volcanic Province'.

My thanks are due to Dr. B. C. Roy, Director, Geological Survey of India, for permitting me to present this note, and to Mr. S. Narayanaswami for his helpful suggestions.

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ROOT RELATIONS OF *OROBANCHE* AND ITS HOSTS

AN extensive morphological study of *Orobanche* in relation to its various host roots at Varanasi revealed that the root branches of cruciferous hosts, specially of *Brassica* sp. on which the roots of *Orobanche cernua* grows, are more developed than the normal roots of the plant. In one case (Fig. 1) the only root branch on which *Orobanche* was growing developed upto 50 cm. More interesting is the fact that the host roots were found to extend to the parasite roots sometimes to a considerable distance either plagiotropically or ageotropically.

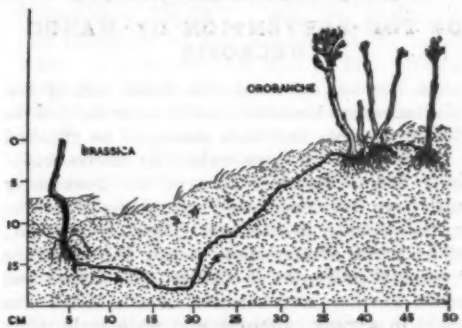

FIG. 1

Orobanche growing on *Brassica* sp. possesses poorly developed roots which entangle the *Brassica* roots. Roots of the former are hardly 1½" long and without hairs.

With storage roots as those of turnip and radish, the root system of the parasite is much developed as compared to the other cases. But in these cases also the roots of the host turned markedly upward just to reach the parasite. Further investigation is in progress to reveal the nature of this stimulus which is found to be absent with the hosts belonging to other families.

Orobanche is a complete root parasite as evidenced by the lack of chlorophyll. The present literature on it suggests that the seeds germinate only when they get hold of the host root. The parasitised plants have been found to have normal, if not healthier development of roots than other plants. Thus these three phenomena, *viz.*,

1. Much longer growth of parasitised root branches.

2. Negative geotropic curvature shown occasionally by the parasitised root branch.

3. The healthier growth of host plants led us to believe that the host has some affinity with *Orobanche*. The peculiar behaviour of the host root may be explained on the following two lines.

(*a*) There might be certain exudations from *Orobanche* which attract the nearest root of the host.

(*b*) The host derives some benefit from *Orobanche*.

We are very much thankful to Prof. R. Misra for guidance.

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Hindu University, R. S. Ambasht.
Varanasi-5, *June* 10, 1958.

ON THE PREVENTION OF MANGO NECROSIS

Mango necrosis in which the distal end of the fruit becomes characteristically necrotic due to brick-kiln fumes has been shown to be checked or prevented to a large extent by boron treatment. When boron is sprayed on trees *after* fruits have developed early symptoms of necrosis, the disease is checked (Das-Gupta *et al.*, 1950),[1] while similar spray *before* the incidence of necrosis prevents the disease (Das-Gupta and Sen).[2] Further corroboration of this result was sought in a more intensive and wide-scale study of the spray effect of boron on mango necrosis this mango season (1958), and the results are briefly described here. The full paper will soon be ready for publication.

The experiments were conducted in two orchards known to suffer regularly from necrosis. Orchard I has one brick-kiln on west and three others on north-west direction all within a radius of half-a-mile from the orchard. This orchard has four major plots, A, B, C and D; A being nearest to the kiln, and D farthest. Orchard II has one brick-kiln on west and another on south within a radius of half-a-mile from the orchard. This orchard has five major plots, A, B, C, D, and E of which A, B and C are nearest to and E farthest from the kiln. The different varieties of mango trees in both the orchards were *Dasehri*, *Safeda* and *Khajri*. All varieties develop necrosis to a varied extent.

In Orchard I spraying was done on 98 trees in plot A, 146 trees in plot B and 257 trees in plot C, and in Orchard II, 29 trees in plot A, 52 trees in plot B, 83 trees in plot C and 142 trees in plot D. The treatment was given thrice before flowering, during flowering and immediately after fruit-setting, with 6 lb. of borax per 100 gallons of well or canal water. Three hundred and eighteen trees in plot D of Orchard I and 83 trees in plot E of Orchard II were not treated, being kept as controls.

The progress of the disease was kept under observation periodically and a final fruit count made when the fruits have attained a size of approximately 4". However, it was observed that the crop was poor in Orchard II. Fruits showing least visible ætiolation were considered as diseased fruits.

Table I

Incidence of necrosis in boron-treated and control plants

Orchard No.	Plot No.	Treated (T) or Control (C)	No. of Healthy fruits	No. of diseased fruits	Total No. of fruits	Percentage of necrosis
I	A	T	1622	60	1682	3·57
	B	T	9293	115	9408	1·22
	C	T	3997	20	4017	0·50
Total	A, B, C.	T	14912	195	15107	1·28
	D	C	1070	1976	3046	64·87
II	A	T	267	..	267	0·00
	B	T	113	..	113	0·00
	C	T	445	21	466	4·50
	D	T	1357	8	1365	0·59
Total	A, B, C, D.	T	2182	29	2211	1·31
	E	C	204	158	362	43·65
Total	I & II	T	17094	224	17318	1·29
Total	I & II	C	1274	2134	3408	62·62

Thus in Orchard I the percentage of disease among test plants is 1·28 while that for the controls is 64·87; in Orchard II the percentage of disease among test plants is 1·31, against 43·65 in controls. Considering all the treatments together the percentage of disease among test plants is 1·29 while that of the controls is 62·62. Correcting for the percentage of healthy mangoes in control plants, it was found

statistically that the percentage of necrosis in test plants will be 2·06 when controls are 100% necrotic, i.e., 97·94% fruits are prevented from getting necrotic by treatment with borax.

The analysis of the data clearly shows that there is preventive effect of boron on mango necrosis. This and the results of the investigation of the past few years lead irresistibly to the conclusion that the mango necrosis can be successfully controlled by spraying the trees with sufficient quantity of boron.

Dept. of Botany, S. N. Das-Gupta.
Lucknow University, C. Sen.
Lucknow, *June* 16, 1958.

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ROLE OF NITROGEN IN HOST SUSCEPTIBILITY TO *PIRICULARIA ORYZAE* CAV.

That heavy nitrogenous manuring augments the disease-proneness of susceptible rice to *Piricularia oryzæ* but not the resistant ones is well recognized.[1-3] Further, it is known that not infrequently normal suscepts behave like resistant ones either in the field or in laboratory inoculation trials. In an attempt to explain this phenomenon on the basis of the environment altering the host metabolism, it has been repeatedly found in this laboratory that the prevailing nyctotemperatures largely determine the susceptibility of rice to the blast disease.[4] Experiments conducted in this regard have shown that a nyctotemperature of 20° C. alternating with day temperatures of 30-35° C. under a fixed illumination for 14 hr. and darkness for 10 hr. render the susceptible types to take infection. Whereas, in plants grown with higher nyctotemperatures (above 26° C.), infection seldom occurs even on the susceptible types.

The effect of low nyctotemperatures on the nitrogen metabolism of the host was investigated, and, indeed, it was found that low nyctotemperatures favoured amide synthesis, especially glutamine which was identified chromatographically in the guttates. The concentration of this amide in the guttate characteristically increased when the plants were also heavily dressed with ammonium sulphate. The guttation fluid when dried on the leaf surface left easily identifiable macroscopic crystals, mainly of glutamine. When pure glutamine as well as that from the guttate was studied for their effect on germination of *P. oryzæ* spores, marked stimulation of germination was observed over a wide range of concentrations. But this stimulation was obvious only at a temperature of 24-26° C., a range established by many workers to be the optimum for infection of rice plants by *P. oryzæ*. At temperatures below or above this optimum, glutamine had no stimulating effect, possibly, due to the disfunction of the glutamic decarboxylase system of the pathogen. Recently, Weintraub *et al.*,[5] reported the stimulating effect of guttates from rice on *Piricularia* spores but failed to identify the substance concerned with any of the number of sterols, steroidal sapogenins, steroidal amines and α-tocopherol which also stimulated germination. But from the foregoing, it is evident that glutamine crystals on the leaf surface provide a readily assimilable substrate for the germinating *Piricularia* spores under the right conditions.

To sum up, it is clear that two factors are concerned in determining the host susceptibility to this disease in so far as the nitrogen metabolism of the plant is concerned. The foremost is the low nyctotemperature which facilitates nitrate reduction and favours glutamine synthesis. Secondly, the prevalence of the optimum temperature (24-26° C.) aids the utilisation of this glutamine by the pathogen at the infection court. It is conceivable that at high nyctotemperatures, amide synthesis is impaired as a result of low nitrate reduction as reported by Went[6] in the case of tomato leaves. Possibly, in this case, the products of photosynthesis are largely diverted to the formation of complex cell-wall materials like lignin and cutin which make the leaf-blade resistant to mechanical puncture by the germ tubes. It is not clear in what way the resistant types differ in glutamine synthesis from the suscepts. It is however known that environmental conditions like long-day stimulus and night temperatures as well as genetical factors are involved in the biogenesis of glutamic and related compounds in plants.[7] Further work on the interrelationships of these factors in relation to glutamine synthesis by rice, resistant and susceptible to *P. oryzæ*, is in progress and would be reported in detail elsewhere.

I wish to record my sincere thanks to Prof. Dr. T. S. Sadasivan, Director, University Botany Laboratory, Madras, and Dr. C. V. Subramanian for many helpful discussions and guidance. The award of a National Institute of Sciences of India Junior Fellowship is also gratefully

acknowledged during the tenure of which this work was carried out.

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A NOTE ON *COLEUS PARVIFLORUS* BENTH.

THE genus *Coleus* contains species of both ornamental and economic value. The one most commonly cultivated in gardens is *C. blumei* Benth. of Javanese origin which is noted for its beautiful mottled leaves with deep purple and red pigments. There are many varieties of this species existing in cultivation, some of which are very high polyploids. The chromosome numbers reported for this species are $2n = 24$[1] and $2n = 48$ and 72.[2] Several other ornamental species have also been introduced from Central Africa.

Amongst the edible species of *Coleus* is *C. barbatus* Benth. the roots of which are pickled and eaten in Bombay State. Even more important as a cultivated plant in South India is *C. parviflorus* (Syn. *C. tuberosus* Benth.) commonly known in Tamil as "Koorgan kilangu" which is widely cultivated for its edible tubers. The plant is a small herbaceous annual with succulent stem and aromatic leaves, grown in Kerala during the monsoon. The plant is easy to propagate and needs very little attention, thriving well on sandy soil. A single tuber germinates within a fortnight giving rise to a cluster of sprouts. The top of the suckers with 4 to 5 leaves are nipped off and planted in rows; these get established very quickly and in their turn give rise to a new set of suckers. By repeating the process large areas can be cultivated in a short period using the minimum seed material. The small blackish brown tubers are rich in starch and protein, have an aromatic flavour and are commonly used as a substitute for potato.

A survey of the tubers collected in Kerala showed much variation in size. Two distinct varieties were noted, one with small and the other with big tubers. These are being grown at the Central Botanical Laboratory as a possible new economic crop for Uttar Pradesh. Chromosome studies on these plants were made from the tubers grown in pots. Root-tips were pretreated with 8-oxyquinoline, and somatic squashes were made following the technique adopted by Tjio and Levan.[4]

The diploid number of the species which has been reported for the first time was found to

FIG. 1. Somatic chromosomes of *C. parviflorus* ($2n = 64$) ×2,400.

be $2n = 64$ chromosomes (Fig. 1). No difference was found in the chromosome numbers of the small and the big varieties. It is interesting to note that *C. aromaticus* Benth., another cultivated plant of medicinal value, has $2n = 32$ chromosomes and a basic number of $x = 8$.[3] *C. parviflorus* has also the same basic number of $x = 8$ and is thus a high polyploid.

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STEM ROOT OF *RAUWOLFIA SERPENTINA*

CERTAIN experimental trials on the vegetative propagation of *Rauwolfia serpentina* Benth. ex Kurz., were being conducted at the Morris Arboretum, Philadelphia, U.S.A., during September 1956. Among the trials with shoot-tip soft wood cuttings, it was noted that one batch of 3-week-old cuttings became thin at the region of the stem near the level of soil and began to rot at the affected part (Fig. 1).

The infected parts of the stem cuttings were removed, surface sterilised with 0·01% mercuric chloride for 1 min., washed in several changes of sterile water and plated out on standard potato-dextrose agar, when all the platings gave out *Rhizoctonia* sp.

FIG. 1. Stem rot of *Aanwolfia serpentina* caused by *Rhizoctonia* sp.

Previously sterilised stem bits of *R. serpentina* of about 1" in length were buried in the infected soil and were subsequently removed and plated out on standard acidified potato-dextrose agar, after a period of 7 days. The following fungi were isolated from the stem bits thus plated: *Rhizoctonia* sp., *Rhizopus* sp., *Trichoderma* sp., *Fusarium* sp., *Aspergillus niger* and *Penicillium* sp.

Pathogenicity trials with the individual isolates, made with 21-day soil-oat inoculum, failed to cause the stem rot when freshly cut and healthy shoot-tip cuttings of *R. serpentina* were planted in the inoculated soil; except *Rhizoctonia* sp. which gave 80% infection causing stem rot. By plating out the infected stem cuttings, the pathogen, *Rhizoctonia* sp., was reisolated.

Thanks are due to Prof. Dr. John M. Fogg Jr., Director, The Morris Arboretum, Philadelphia, U.S.A., for his valuable advice and helpful criticism, and to Olin Mathieson Chemical Corporation, New York, for the award of a research grant.

The Morris Arboretum, Philadelphia-18, Pa,

P. D. VARADARAJAN.*

June 11, 1958.

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HEAD ORGAN PATTERNS OBSERVED IN SOME INDIAN FRESH-WATER DACTYLOGYRIDS; *TREMATODA-MONOGENEA*

CHARACTERISTIC glandular bodies occurring in the cephalic lobes of almost all members of the family Dactylogyridæ have been variously named by different authors as *cephalic bodies*, *anterior adhesive organs* or *adhesive organs*. Johnston and Tiegs[10] called them head organs. Later workers like Mizelle,[11] Mueller,[12] and Hargis[1] adopted the same term which is now in universal use.

The author (Jain[3–9]) used the same term while describing these organs in some Indian dactylogyrids. It appears that no attempt has so far been made to classify the various diverse patterns of head organs. The main difficulty has been that many old descriptions lack a clear diagram of these organs and almost all recent descriptions omit the diagram altogether.

During my investigation, however, it was possible to draw detailed diagrams and make a close study. Hargis'[2] chloretone technique was used for the recovery of trematodes from the gill filaments of fishes. It gave the immediate advantage of getting fresh trematodes for study which are naturally more transparent.

The various types of head organs, I have come across, can be conveniently classified into two main groups: A—in which the head organs

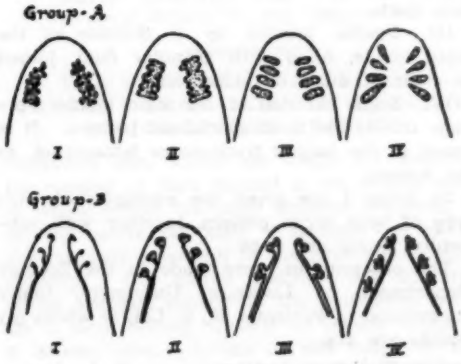

FIG. 1

do not communicate with each other, there being no duct or canal to join all organs of one side, and B—in which there are definite channels on either side, joining all the organs of that side. Each group, A and B, can be further subdivided into four main types, as follows:

TABLE I

Group	Type	Subfamily Dactylogyrinæ	Subfamily Tetraonchinæ
A ..	I	..	**Urocleidus rhycobdelli*
	II	..	*Urocleidus notopteri* Jain, 1955
	III	*Dactylogyrus multispiralis* Jain, 1957	**Bifurcohaptor indicus*
			Thaparocleidus wallagonius Jain, 1952
	IV	*Neodactylogyrus cotius* Jain, 1957	**Urocleidus xenentodi*
B ..	I	..	**Urocleidus vachius*
			**Urocleidus polyspiralis*
	II	..	*Mizelleus indicus* Jain, 1957
	III	*Neodactylogyrus calbasi* Jain, 1957	..
	IV	..	**Bifurcohaptor giganticus*

* Indicates the name of trematodes descriptions of which are still in press.

Group A

I. *Disorganised* small rounded glands, perhaps most simple and primitive.

II. *Compact* organ on either side, with irregular margins, as if by fusion of smaller glands.

III. *Lobate* organs on either side. Each lobe divided into distinct lobules.

IV. *Specialised* lobes on either side. Each lobule in pair with definite shape: rounded distal end and sharp conical proximal end.

Group B

I. *Primitive* small rounded glands, joined to a common duct on either side.

II. *Swollen sac-like* glands, filled with clear granular fluid, on either side, joined by common ducts.

III. *Double lobules* by a division of the main lobule, filled with granular fluid, joined to common ducts on either side.

IV. *Triple division* of the main lobule. Perhaps this is the most specialised pattern. It is found in the largest fresh-water tetraorchid, so far known.

In Table I are given the examples of each type of head organ pattern, together with subfamily, group and type.

The observations were made in the Zoology Department of Lucknow University, under supervision of Professor M. B. Lal, to whom my thanks are due.

Indian Statistical Institute, S. L. JAIN.
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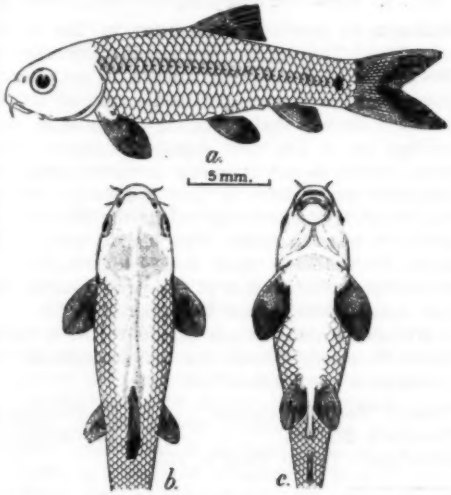
GARRA ETHELWYNNAE, A NEW CYPRINID FISH FROM ERITREA (AFRICA)*

DIAGNOSIS: A *Garra* attaining a standard length of 28·0 mm.; with smooth snout, two pairs of barbels and the back, chest and belly naked. There are 32 to 34 scales in lateral line. The vent is situated very near the origin of the anal fin. The air-bladder is well developed. The colour is dark grey above, paler beneath with a broad lateral band along the middle of the side.

Range.—Salamona, Eritrea (Africa).

Description.—(Text-Fig. 1): Depth of body 3·51 (3·11-3·91) in standard length, length of head 3·53 (3·50-3·58). Width of head 1·29 (1·20-1·33) in length of head, height of head 1·29 (1·20-1·33). Pupil of eye a little in front of the middle of the length of head. Inter-orbital region flat. Snout rounded, smooth, 2·58 (2·40-2·67) in length of head, diameter of eye 3·40 (3·00-4·00), inter-orbital width 1·99 (1·71-2·28). Two pairs of barbels smaller than diameter of the eye. Nine outer gill-rakers in the lower part of the anterior arch. Mental disc well developed. Length of disc 3·40 (3·00-4·00) in length of head, width 2·33 (2·00-3·00) in width of head; length of disc 1·15 (1·00-1·25) in its own width. Thirty-two to thirty-four scales in lateral line, 4·5 from the origin of dorsal to lateral line, 3·5 or 4·5 between

this and pelvic. Back, chest and belly naked; post-pelvic region scaly. Dorsal III, 7; distance between its anterior origin and tip of snout 1·82 (1·79-1·87) in standard length. Length of pectorals 1·29 (1·20-1·33) in length of head. Distance between anterior origins of pelvic and anal fins 1·99 (1·80-2·08) in that between anterior origin of pelvic and base of caudal fin. Anal II, 5. Distance from vent to anal fin 9·33 (6·00-12·00) in that between anterior origins of pelvic and anal fins. Length of caudal peduncle 1·85 (1·78-2·00) in length of head, width 1·15 (1·12-1·20) in its own length.



TEXT-FIG. 1. *Garra ethelwynnæ* Menon (sp. nov.).
a. Lateral view of paratype (Z.S.I. Reg. No. F 859/2).
b. Dorsal view of the same.
c. Ventral view of the same.

Posterior chamber of air-bladder measured in one specimen 25·0% in standard length.

Colour, in alcohol, dark grey above, paler beneath, a broad lateral band from gill openings to the base of the caudal fin and a black spot at the upper angle of the gill openings.

Holotype.—In British Museum (Natural History), London, Reg. No. 1950.5.31.19; Salamona, Eritrea, standard length 28·0 mm., donated by the Sudan Museum (D. J. Lewis).

Paratypes.—One in British Museum (Natural History), London, taken along with the holotype and bearing the same data, standard length 28·0 mm., one bearing the same data as the holotype in the Zoological Survey of India, Calcutta, Reg. No. F 859/2, standard length 21·5 mm.

Relationships.—In my taxonomic monograph on *Garra* which will be published soon in the *Memoirs of the Indian Museum*, *G. ethelwynnæ* is placed under the *tibanica*—complex of species. The members of this complex exhibit 9 to 11, rarely 12 outer gill-rakers on the lower part of the anterior arch, a well developed air-bladder, a row of dark spots at the base of the branched dorsal rays, and a broad dark band from behind the gill openings to the base of the caudal fin. Included in this complex are *tibanica*, *quadrimaculata*, *ignestii*, *ornata*, *trewavasi*, *makiensis*, *dembeensis* and *ethelwynnæ*. Their distribution is now at or towards the western extremity of the range of the genus apparently because they are evolutionarily very old and probably an early stock given off from the evolutionary centre of the genus in South-East Asia.[1,2] *G. ethelwynnæ* is a dwarf cognate of *G. tibanica*[3]; the scaleless nature of the back, chest and belly, however, easily distinguish it.

Zoological Survey of India, A. G. K. MENON.
Calcutta, *May* 24, 1958.

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* Published with the kind permission of the Director, Zoological Survey of India, Calcutta.

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THE FREE AMINO NITROGEN CONTENT AS AN INDEX OF QUALITY OF ICE-STORED PRAWNS

OBJECTIVE tests which are useful for assessing the number of days elapsed in ice storage and/or which reflect the early changes occurring in prawns before the onset of spoilage are essential for quality control in the prawn processing industry. Our earlier findings[1] that the free amino nitrogen content of the crustacean muscle is over 300 mg. N/100 g. of muscle whereas it is only about 1/10th of this value in the fishes suggested that the determination of amino nitrogen might be of use in studies on crustacean spoilage. Hence this determination was included among other chemical and bacteriological tests in investigations on the quality of ice-stored prawns which are in progress at this Station. The results of one series of observations on prawns obtained at Mandapam and also on prawns landed at Cochin on the West Coast are shown in Figs. 1 and 2.

It is seen that the decrease in amino nitrogen is more regular than the decrease in the orthophosphate which shows some scattering. Also there is close agreement in the amino nitrogen values of the Mandapam prawns and Cochin prawns after equal periods of storage in ice. Bailey *et al.*[2] did not include amino N among the tests which show definite changes in the prime quality of ice-stored prawns but considered it among other tests for judging the relative quality. Our observations on prawns comprising of different species* and taken from different environs indicate that definite ranges of amino N values are associated with the number of days in ice storage. Values of over 200 mg. N/100 g. characterise the first two days, values between 100 and 200 mg. the next three or four days and values below 100 longer durations. According to Bailey *et al.* (*loc. cit.*) the prime quality phase of ice-stored prawns lasts for about six days. The rapid decrease in amino N is seen to be arrested about the sixth or seventh day (Fig. 1). It appears therefore that

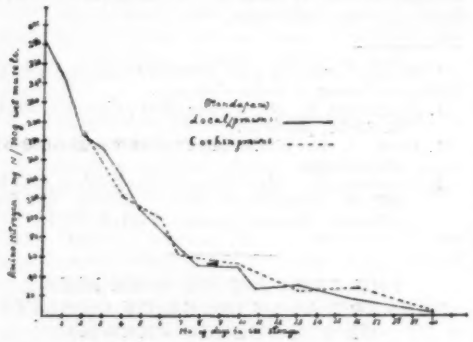

FIG. 1. Decrease in amino N during ice storage.

the amino N is also useful as the other tests mentioned by Bailey *et al.* The determination of amino N by the method employed[3] is simple, accurate and needs no special equipment or instruments.

Campbell and Williams[4] had reported an increase in the amino N in Gulf coast shrimps during ice storage; but Fieger and Friloux[5] observed a decrease in the amino N. Our observations are in agreement with those of the latter workers; however, the fall in amino N is more rapid and much lower values are reached after two weeks' storage in ice in our experiments. The reason for this is not clear at present. The initial amino N values for Gulf coast shrimps reported by Fieger and Friloux are of the same level as in Indian prawns, crabs and lobsters reported by us (*loc. cit.*).

Bailey *et al.* attributed the differences in their observations and those of Campbell and

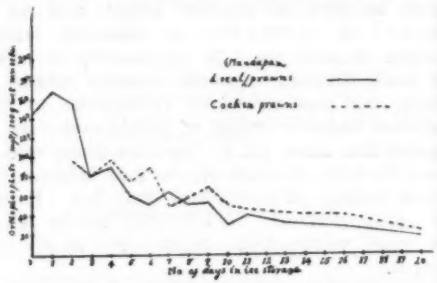

FIG. 2. Decrease in orthophosphate during ice storage.

Williams to possible differences in the bacterial flora. The mechanism of the decrease in the amino N during ice storage is not clearly elucidated yet; but experiments carried out by us have shown that leaching by contact with melting ice is the most significant factor. Bacterial action is not probably involved since the bacterial population is low especially during the early days of storage when the decrease in amino N is most rapid. The loss of free amino acids by leaching may itself contribute to a lessening in the flavour of the prawn meat. The full investigations will be reported later.

We wish to express our thanks to Dr. S. Jones, Chief Research Officer, for encouragement and permission to publish this note.

Central Marine Fisheries Research Station, Mandapam Camp, *June* 5, 1958.

N. K. VELANKAR.
T. K. GOVINDAN.

* The Mandapam prawns consisted entirely of *Penaeus indicus* and the Cochin prawns of *Metapenaeus dobsoni*, *M. affinis*, *M. monoceros* and *P. indicus*, the first being predominant.

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THE VISITS OF INSECTS TO DIFFERENT COLOURED FLOWERS OF *LANTANA CAMARA* L.

Lantana camara L. exists in two varieties, one in which the flowers contain yellow pigment, and the colour changes from yellow to orange as red pigment develops, the other in which yellow pigment is absent, and the flower colour changes from white to pink. I hope to investi-

gate the genetics of this difference. Meanwhile, as mixed populations are very common, it seemed worthwhile to find out whether mating was at random in nature. From 29th May to 5th June 1958, I watched three plants with yellow pigment and three without it in the morning from 8 a.m. to 9 a.m. The only insects seen visiting the flowers were the Lepidopteran species *Precis almana* L. and *Catopsilia pyranthe pyranthe* L. I often noticed that more than one of the latter species visited the plants at a time.

TABLE I

Numbers of insect visits to flowers of Lantana camara L.

	Butterfly	No. of visits to red-yellow flowered plants	No. of visits to white-pink flowered plants
I	*Precis almana* L. ..	12	0
II	*Catopsilia pyranthe pyranthe* L.	2	25

The numbers of visits are given in Table I. With two exceptions, each species remained true to one variety.* In so far as these species carried pollen from one flower to another the two varieties were almost endogamous. It is of course possible that at other times of year there may be much more crossing. However, if one of the two varieties of *Lantana camara* L. is recessive to the other, a population must contain much fewer heterozygotes than the number calculated if matings were at random.

There is plenty of evidence[2,3] that a Lepidopteran species may prefer one colour to another, and that this preference varies between species. And there is evidence[4] dating back for over 2,000 years that insects distinguish between different species. So far as I know, however, this is the first evidence that two different insect species each prefer one of two varieties of the same plant species. The observation has several interesting evolutionary consequences. The relative abundance of the two insect species might determine the relative abundance of the two colour varieties in a given area and perhaps conversely. And selection by insect pollination offers a possible method by which one species could give rise to two species.

I am thankful to Dr. H. Spurway for valuable criticism and advice. My sincere thanks are also due to Dr. A. P. Kapur of Zoological Survey of India, for the identification of one of the butterflies; to Professor J. B. S. Haldane, F.R.S., for suggestions and helpful interest and to Professor P. C. Mahalanobis, F.R.S., Director, Indian Statistical Institute, for the facilities I enjoyed during the work.

KRISHNA R. DRONAMRAJU.
Biometric Res. Unit,
Indian Statistical Institute,
Calcutta-35, *July* 7, 1958.

* Fisher's[1] exact method shows that the probability that this selectivity in visiting should be due to chance is $2 \cdot 327 \times 10^{-6}$.

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† Seen in the abstract form.

A NOTE ON THE EXTERNAL ANATOMY OF *PRECIS ORITHYA* SWINHOE (NYMPHALIDAE: LEPIDOPTERA)

Precis orithya Swinhœ, a butterfly commonly known as the 'Blue Pansy' in view of the resemblance of its wing pattern to that flower, has been recorded breeding on *Striga euphrasioides*, a weed parasitic on the roots of sugarcane. It appears in the field as early as May and is most active between July and October, after which with the onset of winter its population decreases rapidly. It overwinters as an adult. Agarwala and Naqvi[1] have studied its bionomics and natural parasitism as well as its alternate host plants by carrying out exhaustive starvation tests. In this note a brief account of the external anatomy of its various stages is presented.

Egg.—Small, athalia, acorn-shaped, light green in colour with 15 longitudinal flanges or keels.

Larva.—Thin, long, cylindrical, measuring on an average 1·5 mm. in length when freshly hatched and 25 mm. when full grown.

Head capsule dark brown in colour, conspicuously two-humped, having a pair of scoli; carries a large number of bristles (Fig. 1). Vertex cut out by the posterior emargination of the dorsal wall of the cranium. Antennæ very small, 3-segmented, situated on the anterior edges of the epicranials. Ocelli, six on each epicranial plate, three on dorsal side and three on latero-ventral side. Frons extremely modified and transformed into an inverted Y-shape by the upward growth of clypeus into its

ventral part; the stem of Y sunken into the head by a median invagination of the head wall above the apex of the clypeus, and the arms of the Y (adfrontals) forming narrow strips between the clypeus and parietals.

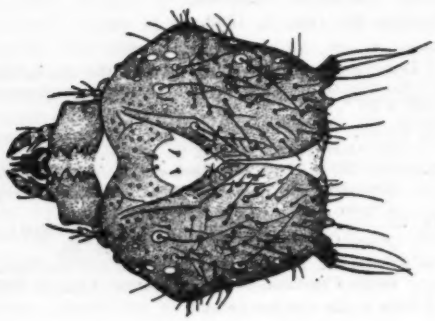

FIG. 1. Head capsule.

Thorax and abdomen sooty black in colour covered with sharp and complex spines and bristles borne on 9 longitudinal rows of pointed scoli. Scoli well developed, each bearing a number of setæ. Four pairs of prolegs and a pair of claspers present; crochets multiordinal arranged in meso-series forming incomplete circles; five pairs of indistinct, elongated oval spiracles.

Pupa.—Obtect, angular with sharp projections, brown to dark brown in colour, suspended by the tail hook or cremaster (head down) without any silk girdles.

Imago.—Median-sized butterfly with only two pairs of functional legs (both sexes), forelegs being rudimentary, held up against the body; the palpi clearly articulated, the last joint being pointed. Antennæ slender, clavate, dilated apically forming a gradual rounded club, gray in males and dark in females. Eyes smooth.

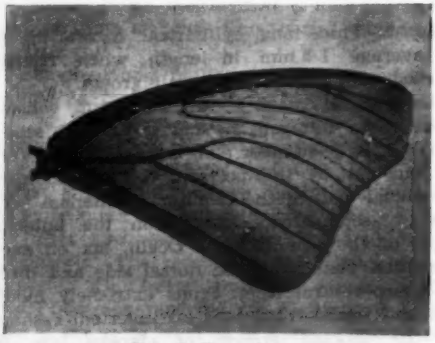

FIG. 2. Fore-wing.

Wings strong, with an expanse of 42 mm. on an average. Venation in fore and hind wings distinctly different, with no distended veins. Fore-wing 1¾ times longer than broad with 12 distinct veins (Fig. 2); Cu 2 absent and only one anal vein 1 A present. Hind wing rounded, shaped like the ear of an elephant (Fig. 3),

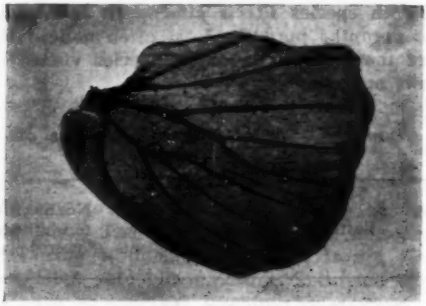

FIG. 3. Hind-wing.

with length 1-½ times more than breadth; frenulum absent; discal cell open; 10 distinct veins; Sc present, Sc + R 1 arising from near the base; Cu 2 absent; two anal veins—2 A very small and strongly curved.

Sincere thanks are due to Mr. K. L. Khanna, Director, Sugarcane Research and Development, Bihar, Pusa, for kind encouragement and providing the necessary facilities.

Sugarcane Entomologist, DHAMO K. BUTANI.
Sugarcane Res. Institute,
Bihar, Pusa, *April* 22, 1958.

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MOLYBDENUM REQUIREMENT OF *SELENASTRUM WESTII* IN TERMS OF ATOMS PER CELL

EVER since Steinberg[7] demonstrated the indispensability of molybdenum and a progressive increase in the weight of the mycelium of *Aspergillus niger* with the increasing concentrations of this element when nitrate is provided as the sole source of nitrogen in the medium, sufficient evidences have been accumulated for a molybdenum requirement by other organisms[2,3,6,8] as well as by higher plants.[1] A critical study has been made recently with special reference to the molybdenum requirement of *Chlorella pyrenoidosa*[6,8] and *Scenedesmus obliquus*[2,3] both belonging to the order *Chlorococcales*. The present communication reports the molybdenum requirement of *Selenastrum*

westii, another member belonging to the same order, *Chlorococcales*.

Chu 10 solution[5] supplemented with Chu's micronutrient solution was used as the basal medium and the iron source in the original medium was replaced by 5 p.p.m. of iron as ethylene diamine tetra acetic acid (Fe-EDTA) and the pH of all the cultures was adjusted to 7·5. Various amounts of molybdenum (as sodium molybdate) were provided to the individual cultures giving a final concentration of 0·001, 0·01, 0·1 and 1 ppb. Mo, while in the control cultures this element was completely omitted. All the cultures were grown under identical conditions under continuous illumination provided by six 3′ 40 watts fluorescent tubes and the culture vessels were inoculated at the rate of 2×10^9 cells per litre. For growth measurements, aliquots were removed daily and the cell counts were made in a hæmocytometer. The results are expressed in Fig. 1.

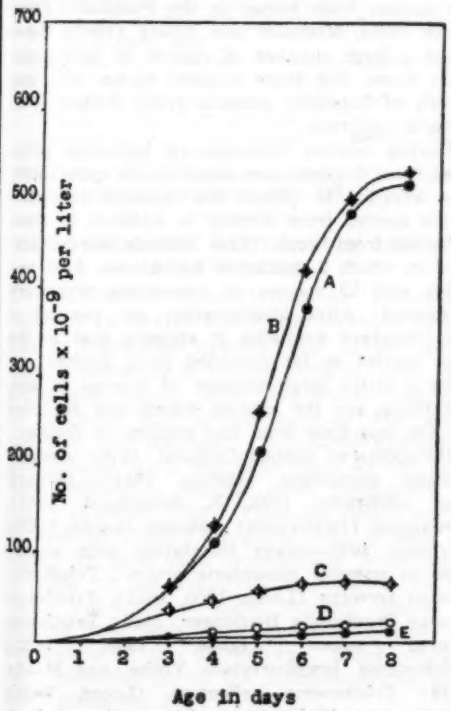

FIG. 1. Growth curves of *Selenastrum westii* at different molybdenum concentrations. (Curves A, B, C, D and E at 1, 0·1, 0·01, 0·001 ppb. Mo and *minus* Mo respectively.)

It is seen from Fig. 1 that in the medium without any added molybdenum (control) the growth is almost nil (curve E) and 0·001 ppb. Mo also is found to be quite insufficient for the normal growth of the alga (curve D). Although there is perceptible growth in 0·01 ppb. Mo, from the curve C it appears that the element soon becomes insufficient and acts as a limiting factor after about 6 days of growth, while 0·1 ppb. Mo proves to be quite adequate for a good growth (curve B) during the experimental period. At still higher concentrations (1 ppb. Mo) there seems to be a slight retardation in the growth rate as seen from the curve A, thereby showing a slight inhibitory effect on the growth rate at a concentration higher than 0·1 ppb. Mo in the medium.

The understanding of the adequate and toxic levels of this element gives a clue to the requirement of molybdenum by the alga in terms of atoms-Mo per cell. The values of atoms-Mo were calculated from Fig. 1, on the assumption that all the molybdenum supplied to the medium have been used up by the alga and consequently the figures given in Table I represent the maximum values. Net cell counts which represent the growth of the alga as the function of molybdenum concentration were calculated by subtracting the number of cells in the *minus* molybdenum culture (*Blank*) from the number of cells in the media provided with different concentrations of molybdenum. The requirement of atoms molybdenum per cell is computed both at the restricted and adequate levels of molybdenum concentration by the formula $g/n \times N$, where g represents the gram-atoms Mo, n, the net cell count and N, the Avagadro's number.[3] The calculated values are given in Table I.

TABLE I

Showing the number of molybdenum atoms per cell of Selenastrum westii

Age in days	Concentration of Mo in ppb. 0·001		0·01		0·1	
	Net cell count $\times 10^{-9}$	Atoms-Mo per cell	Net cell count $\times 10^{-9}$	Atoms-Mo per cell	Net cell count $\times 10^{-9}$	Atoms-Mo per cell
3	4	1600	35	1800	60	10,400
4	5	1200	45	1400	130	4,800
5	6	1000	55	1100	260	2,450
6	8	960	65	960	420	1,500
7	8	960	65	960	500	1,200
8	8	960	65	960	530	1,200

In all the cultures, both with restricted and adequate supply of molybdenum, the rapid growth phase is observed when the concentration of molybdenum was above approximately 1,200 atoms per cell and a drop in the molybdenum atoms level below 1,000 atoms per cell results in the cessation of the growth in the series with restricted supply of molybdenum (0·001 and 0·01 ppb. Mo) and in the series with adequate supply the growth rate appreciably decreases with a decrease in the molybdenum level per cell. To ensure good growth of *Selenastrum*, about 1,500 atoms-Mo per cell are required and cell division ceases when the supply of molybdenum falls below this level.

On comparison with Azotobacter[4] and *Scenedesmus obliquus*,[3] *Selenastrum westii* has a very low molybdenum requirement and this substantiates the catalytic role of this trace element in the general metabolism of this alga. Further, the inhibitory level of molybdenum concentration for *Selenastrum westii* is much less than that for *Scenedesmus*.[3] It is also observed that in the molybdenum-deficient cultures, the material accumulates abundant starch and the cell division also is considerably arrested. The low levels of molybdenum concentration (0·001 and 0·01 ppb. Mo) at which such deficiency symptoms are noted are in close agreement with higher plants[1] and *Scenedesmus obliquus*.[3]

In conclusion, we record our sincere thanks to Dr. M. S. Randhawa, Dr. B. P. Pal and Dr. S. M. Sikka for their keen interest and encouragement throughout the investigation.

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Botany Division, K. V. NATARAJAN.
I.A.R.I.,
New Delhi-12, *May* 26, 1958.

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PRELIMINARY LIST OF HELMINTH PARASITES OF DONKEY (*EQUUS ASINUS*)

THE occurrence of a large number of helminth parasites has been widely recorded from horse, donkey and mule, but of these equines, horse alone appears to have received so far some attention in this country. Bhalerao (1935) recorded four species of worms, *viz.*, *Schistosoma indicum*, *Anoplocephala magna*, *A. perfoliata* and *Parascaris equorum* from ass or donkey. In his classified list of hosts, Baylis (1936) mentioned under horse, donkey and mule, 33 species of nematodes, and in dealing with the various species, he invariably observed that these parasitise, horse, donkey, mule and zebra, but in no case has donkey been specifically mentioned as a host. The accounts of the species incorporated by Baylis are based on the records and observations of Boulenger (1921) and Gaiger (1910 and 1915) who have recorded the species from horses in the Punjab. From South India, Mudaliar and Alwar (1947) have listed a large number of species of nematodes from horse, but there appears to be only one record of helminth parasite from donkey, *viz.*, *Ascaris equorum*.

During routine collection of helminth parasites from domesticated animals, an opportunity was afforded to collect the common representative species from donkey in addition to those collected from horse. Three animals were examined in which 2 species of trematodes, 2 of cestodes and 19 species of nematodes were encountered. After identification and perusal of the literature available it appears that to the four species so far recorded from donkey, we have a fairly large number of species to add. Following are the species which are recorded for the first time from this country in donkey.

Pseudodiscus collinsi Cobbold, 1875; *Anoplocephala mamillana* (Mehlis, 1831); *Oxyuris equi* (Schrank, 1788, E. Blanchard, 1849); *Strongylus* (*Delafondia*) *vulgaris* (Looss, 1900); Skrjabin, 1935—heavy infestation with aneurisms in anterior mesenteric artery; *Triodontophorus serratus* (Looss, 1900, 1902); *Triodontophorus brevicauda* Boulenger, 1916; *Triodontophorus minor* (Looss, 1900, 1902); *Trichonema longibursatum* Yorke and Macfie, 1918; *Trichonema calicatum* (Looss, 1900); *Trichonema* (*Cylicostomum*) *ægyptiacum* Railliet, 1923; *Trichonema* (*Cylicocyclus*) *insigni* (Boulenger, 1917); *Trichonema* (*Cylicocercus*) *pateratum* (Yorke and Macfie, 1919); *Trichonema* (*Cylicocercus*) *goldi* (Boulenger, 1917); **Trichostrongylus axei* Cobbold, 1879; *Dictyo-*

caulus arnfieldi (Cobbold, 1884) Railliet and Henry, 1907; *Habronema muscæ* (Carter, 1861), Diesing, 1861; *Habronema microstoma* (Schneider, 1866), Ransom, 1911; *Habronema megastoma* (Rudolphi, 1819);—heavy infestation with a big-sized tumor; *Gongylonema pulchrum* (Molin, 1857)—in wall of œsophagus and stomach; *Setaria equina* (Abildgaard, 1789)—Raillet and Henry, 1911.

The authors are grateful to Dr. B. P. Pande for his guidance and for going through the manuscript. Thanks are due to Sri. C. V. G. Choudary for the facilities provided.

Dept. of Parasitology, U.P. College of Veterinary Science and Animal Husbandry, Mathura, Uttar Pradesh, *May* 12, 1958.

P. Rai.
J. S. Srivastava.

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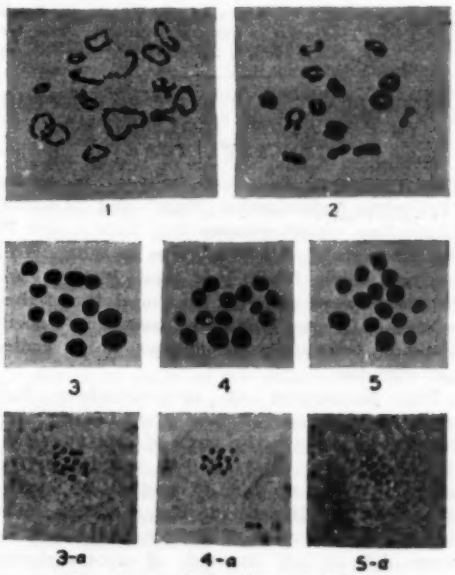
CYTO-GENETIC STUDIES IN INDIAN SILKWORMS

I. Preliminary Observations on Spermatogenesis in Castor Silkworm, *Attacus ricini*

Castor silkworms provide one of the major cottage industries in certain parts of India. The unreelable cocoons yield fibre which, compared to mulberry silk, is less lustrous but much stronger and durable. Extensive cytological and genetic work has been done on the mulberry silkworm, *Bombax mori*, particularly in Japan (Tanaka, 1953). From the recent review by Makino (1953), the genus *Attacus* does not appear to have been cytologically investigated. In view of the industrial importance of the castor silkworm of India, various species of *Attacus* have been taken up for cytogenetic investigation in this laboratory. Some preliminary observations on the spermatogenesis have been presented here.

Examinations at late larval and early pupal stages revealed that various stages of spermatogenesis occur during first four to five days of pupal stage after completion of cocoons. Pupal testes were dissected, smeared and fixed in Navashins fluid, rinsed in water and stained with crystal violet. Camera lucida drawings were made at bench level with 100 × oil immersion and 25 × compensating eyepiece. Photomicrographs were taken at 1000 × magnification.

During early diplotene paired chromosomes show well-defined primary constrictions. Two large pairs show distinct satellites, one having sub-median and other a median constriction. Shorter pairs show two terminal chiasmata and the longer ones have both interstitial and terminal chiasmata. Terminalisation is complete at late diakinesis. Metaphasic orientation is equidistant and does not suggest any secondary associations. No multivalent associations occur there being regular 14 bivalents. Two of these bivalents are comparatively larger, two smaller and remaining ten bivalents have more or less uniform size. (Figs. 1 to 5 and photomicrographs).



Spermatogenesis in *Attacus ricini*.

FIGS. 1 and 2. Diakinesis, FIGS. 3, 4, 5. Metaphases, all reduced to 1800 × approx.

Photomicrographs 3-*a*, 4-*a*, 5-*a*, corresponding with FIGS. 3, 4 and 5 respectively showing metaphases with 14 bivalents, reduced to 720 × approx.

The foregoing observations reveal that (1) *Attacus ricini* has its chromosome number as $n = 14$ and $2n = 28$, (2) in view of regular bivalent formation, it seems to have typical diploid constitution, (3) in view of presence of chiasmata during spermatogenesis, genetic crossing over in the male is indicated as in *Bombax mori*.

These observations are being critically pursued further. In view of the common basic number 14, both in *A. ricini* ($2n = 28$) and in *B. mori* ($2n = 56$) any possibilities of their phylogenetic interrelations are being investigated.

Thanks are due to Shri S. G. Shende for certain facilities, and Shri C. S. Bhambure and Shri S. R. Salvi for valuable help in the laboratory.

Silkworm Res. Station, Village Industries Board, Bombay State, Govt. Bungalow No. 1, Mahabaleshwar, Dist. Satara North (India), *June* 23, 1958.

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INHERITANCE OF SPOT-VARIATION IN *EPILACHNA* (COLEOPTERA : COCCINELLIDAE)

Two species of *Epilachna* beetles, 12 spotted (*Epilachna dodecastigma* Muls.) and 28 spotted (*Epilachna viginti-octopunctata* Fabr.), are the regular pests of vegetable crops in Bihar. While studying their life-history and biology, spot variations were observed on the elytra of these beetles. It was, therefore, considered worthwhile to investigate the factors which control spot-variation.

The phenomena of spot-variations have caused a lot of confusion in literature for identification work. On the basis of spot-variations, Chopra (1925) reported five species of *Epilachna, viz.*, 12 spotted, 16 spotted, 24 spotted, 26 spotted and 28 spotted. Kapur (1950) stated that the identification of *Epilachna* spp. had become difficult on account of spot-variation. Wesley (1956) carried out studies on spot-variation and concluded that 12 spotted and 28 spotted are one species and designated it as 12-28 *Epilachna* sp.

Stock-culture of the *Epilachna* sp. was maintained on the leaves of potato, tomato and brinjal in glass bottles (10 cm. high and 9 cm. in diameter) with perforated lids. During summer months, a layer of sand 2" thick was placed at the bottom and was kept moist by sprinkling water on the sand layer. Fresh leaves were renewed each day. This breeding technique helped considerably for rearing the insect successfully under indoor conditions.

Results.—(1) The population studies of the *Epilachna* beetle brought to light three pertinent biological facts: (*a*) the 12 spotted beetles were found to outnumber the 28 spotted, (*b*) 12 spotted and 28 spotted were always found in close association on plants, and (*c*) nine types of spot variants (12 spotted, 14 spotted, 16 spotted, 18 spotted, 20 spotted, 22 spotted, 24 spotted, 26 spotted and 28 spotted) were observed. These facts indicated the possibility of cross-breeding between 12 spotted and 28 spotted beetles in nature.

(2) The 12 spotted and 28 spotted beetles were, therefore, isolated and were inbred. The pure inbred races of 12 spotted and 28 spotted were established when inbreeding was practised for six successive generations.

(3) The crosses between the inbred lines of 12 spotted females and 28 spotted males were carried out successfully. The progeny of first generation of the cross yielded nine spot-variations (12 spotted, 14 spotted, 16 spotted, 18 spotted, 20 spotted, 22 spotted, 24 spotted, 26 spotted and 28 spotted). In case of reciprocal cross between 12 spotted and 28 spotted, the females laid eggs, but they failed to hatch. This inviability of eggs may be due either to incompatibility between 12 spotted males and 28 spotted females or to environmental factors. The factors which account for inviability of eggs are still under investigation.

The nine types of spot variants obtained as a result of crossing between 12 spotted and 28 spotted agree with those observed in the field. It seems, therefore, that the nine groups of *Epilachna* beetles are not different species but are variants out of cross-breeding between 12 spotted and 28 spotted in nature. Spot-variations due to cross-breeding between the two related species of *Epilachna* have not been recorded before.

The authors wish to express their deep sense of gratitude to Dr. R. H. Richharia, Principal, for suggesting the problem and providing necessary facilities in the Post-Graduate Laboratory for carrying out the investigation.

Division of Entomology, Bihar Agric. College, Sabour, *June* 2, 1958.

B. S. Lall.
S. C. Mandal.

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REVIEWS

X-Ray Microscopy and Microradiography. (Proceedings of a Symposium held at the Cavendish Laboratory, Cambridge), 1956. Edited by V. E. Cosslett, Arne Engström, H. H. Pattee, Jr. (Academic Press, Inc., New York), 1957. Pp. 645. Price $ 16.50.

The Symposium under review contains 66 separate, but interrelated accounts of progress in the use of X-rays for microscopy, microchemical analysis and microdiffraction. There are extensive discussions of tools and techniques as well as of applications and results in chemistry, biology, medicine and metallurgy.

The low wavelength and high penetrating power of X-rays have for long held out the promise of utilisation in high resolution microscopy. In principle, the simplest way of using X-rays for microscopy is to produce a sharp X-ray shadow of the specimen on a photographic film and to magnify the shadow in an optical or electron microscope. In order to attain high resolution, this method of radiographic microscopy requires the construction of special X-ray tubes (fine focus and soft radiation) and the employment of special cameras. Several descriptions of such apparatus are given. The use of curved mirror systems in making true reflection X-ray microscopes is extensively discussed. Some new ideas in X-ray microscopy, based on image scanning, the synthesis of wavefronts diffracted by X-rays, etc., are presented. It is clear from all this that X-ray microscopy has gone a long way since the pioneering experiments of Kirkpatrick and colleagues. A resolution of 1 μ is now readily attained, while 1000 Å or better is in sight.

The differential absorption of X-rays and the emission of characteristic radiation of different wavelengths by various elements are now being increasingly used for microchemical analysis in the fields of biology, medicine, geology, metallurgy, etc. Detailed accounts of these applications and of some of the results obtained are given.

Other topics discussed include tubes and cameras suitable for micro-diffraction, the use of electronic computers in figuring the contours of reflecting surface, etc.

The Symposium is, of course, written in the language of communication between specialists. However, many of the contributions can be read with profit by any X-ray worker. The editorial standard and the general get-up are excellent.

T. RADHAKRISHNAN.

Aircraft Hydraulics, Vol. II. (*Component Design.*) (Chapman & Hall, London, W.C. 2; India : Asia Publishing House, Bombay-1), 1957. Pp. x + 198. Price 45 *sh.*

This book is the second in the series of two volumes on Aircraft Hydraulics published under the auspices of the Royal Aeronautical Society. It consists of eight chapters written by different authors and edited by Mr. H. G. Conway.

The first chapter is on seals and contains a useful account on the various aspects of the design of seals. The second chapter is on hydraulic pumps and motors. The treatment here is sketchy and is more likely to be of use to the specialist rather than for a young engineer trying to design pumps or motors. The third chapter is on jacks and contains much information useful to the designer.

Selectors and Miscellaneous components are treated in chapters four and six respectively. Miscellaneous components include, among other things, details on accumulators, tanks, filters etc. Illustrations of standard designs from one of the manufacturers is given and attention is drawn to some of the salient features. In fact, this feature is common to most of the material treated in this book. Chapter five on valves is fairly exhaustive and should be of considerable use to the hydraulic systems designer. Chapter seven contains an excellent introduction to hydraulic servo-controls without delving into the mathematical details of servimechanism theory. The last and eighth chapter is on pipework and gives simple rules for selection and layout of pipes and fittings. Some of the pipe coupling illustrations could have been larger and more explanatory.

Except for three or four chapters the book on the whole suffers from an attempt to cover too much ground and reads like a handbook. The book is sure to be of great use as a reference work in design offices but in the opinion of the reviewer it fails to come up to the claim of a text-book on the design of hydraulic components.

S. RADHAKRISHNA.

Solid State Physics, Vol. IV. Editors: F. Seitz and D. Turnbull. (Academic Press Inc., New York), 1957. Pp. xiii+540. Price $ 12.00.

This is the fourth volume of the series and it contains five review articles.

The first article by W. Känzig is a systematic review of the state of our present knowledge of Ferroelectrics and Antiferroelectrics. Starting from definitions and a phenomenological classification, the dielectric susceptibility, the dielectric non-linearity and saturation, the electro-mehanical behaviour, spontaneous polarisation and strain, and the optical properties of the different ferroelectric and antiferroelectric crystals have been individually given. The thermo-dynamic theory is presented in a very clear manner. The structural studies of these substances by X-ray and neutron diffraction, Raman and Infrared spectroscopy have been presented. The article ends by describing the current theories on ferroelectricity. Dr. Känzig's article is of great utility as it highlights some of the gaps that exist in the literature today. For even the very awareness of this would induce many young workers of different disciplines to make contributions to this fruitful field.

The second article is by F. J. Blatt on the theory of the mobility of electrons in solids and it attempts to cover most of the topics that come under the heading of transport or conduction phenomena in solids. The one electron approximation is consistently used in this article and it is further assumed that when moving in a perfect crystal an electron behaves as though it is moving in vacuum, the crystalline structure of matter making itself felt as an alteration of the "effective" mass of the electron. It is probably worthwhile noting that while this simplified model has succeeded in explaining a surprising variety of phenomena, there are a number of observations that have completely eluded explanation. After discussing the statistics of free electrons in metals and semiconductors, the Boltzmann transport equations have been formulated and the solutions for various phenomena like electrical conductivity, thermal conductivity, thermoelectricity, Hall effect, etc., have been derived making the simplified assumption that the energy surface in the wave vector space is spherical. The derivations have been generalised to the case when both the energy surface and the relaxation time are anisotropic. Next the different scattering phenomena arising from thermal vibrations, imperfections, dislocations, faults, etc., have been discussed. Finally the effects arising due to the lack of thermal equilibrium in photon or electron distribution have been treated.

The third article is by T. O. Woodruff on the orthogonalised plane wave (OPW) method. The OPW method is based on the idea that the valence and higher wave functions in a crystal can well be represented as a sum of plane wave-like functions which while slightly modified near atomic sites remain essentially plane over the region of definition of a crystal. The practical methods of obtaining "interesting" solutions for the Schrödinger equation for a periodic potential using the well-known variational techniques starting with a trial function is described. Some of the applications where this technique has been used have been listed. One cannot but be astounded at the magnitude of the calculational effort required to carry out investigations of this type.

The fourth article is by R. S. Knox and it gives an exhaustive bibliography of atomic wave functions.

The last article is on the techniques of zone melting and crystal growing by W. G. Pfann of Bell Telephone Laboratories. It is perhaps the most comprehensive article that has appeared on this subject and would be truly appreciated by all the experimenters who are struggling on this rather difficult field. The technique of preparing crystalline substances for research using zone melting and zone refining techniques forms the central theme of this article. Main emphasis has been given to the removal of impurity, the controlled addition of desired solute atoms and the growth of single crystals controlling the contents of dislocations. After reading this excellent article one cannot but eagerly look forward to Dr. Pfann's forthcoming book on "Zone Melting".

The volume comes up to the high tradition that has been set up by the previous volumes.

S. RAMASESHAN.

Biological Replication of Macromolecules. (*S.E.B. Symposium 12.*) Edited by Sanders. (Cambridge University Press), 1958. Pp. vi + 255. Price 50 *sh.*

Genetics is a science with its own technique and its own terminology. The unit structure is the gene, a molecule or part of a larger molecule which is needed for a particular biochemical process, and which, unlike an enzyme, is copied when a cell divides, and is copied even when it has been changed. If this copying

process can be explained chemically genetics will be reduced to chemistry as chemistry is being reduced to physics. The book before us shows how close we are to such an explanation. The keywork is mostly being done on bacteria and viruses, but some is being done on cells of higher organisms.

Perhaps the biggest items of news, particularly for those who do not read French, are Jacob and Wollmann's account of their discovery that most of the genetic material of *Bacillus coli* is arranged in a ring, which can be broken at a number of places, and then penetrate a receptor or "female" bacillus, and Frédéricq's account of the colicinogenic factors in the same species. The latter are self-replicating or "hereditary" particles apparently independent of the other genes. Sanders, Huppert, and Hoskins give the first exact data on the rate of reproduction of an animal virus.

However, most papers are concerned with protein synthesis, and with the purification of desoxyribonucleic acid molecules which carry the information leading to the synthesis of one protein rather than another. Brown and Brown announce the isolation by chemical methods of such a molecule, but not, of course, its chemical characterization.

Seeing that the book is indispensable for those who wish to study the growing points, both of genetics and biochemistry, it is a pity that the binding is so bad that a page is already loose in the review copy sent to me.

J. B. S. HALDANE.

Technique of Organic Chemistry—Laboratory Engineering, Vol. III, Part II. Edited by Arnold Weissberger. (Interscience Publishers), 1957. Pp. ix + 391. Price $8.00.

The comprehensive issue of the *Technique of Organic Chemistry* is undergoing at present a thorough re-editioning. Nine volumes in all are anticipated. The publication has now progressed to Vol. III, which in itself is subdivided into two separate parts of which Part I has already been published earlier. Part II has now become available and is under review. This part deals with a number of operational procedures and is headed by a chapter on "Selection of Materials for the Construction of Equipment", written by R. F. Eisenberg and R. R. Kraybill. It is followed by a chapter which deals with "Heating and Cooling" by R. S. Egly. Then follows a chapter on "Grinding, Screening and Classifying" by J. W. Axelson and W. C. Streib, "Mixing" by J. H. Rushton, with a sub-chapter on "Special Equipment", by M. P. Hofmann, and finally closes with a chapter on "Operation with Gases" by G. H. Miller. Like all the earlier volumes, the contents of this present issue have been widened, reclassified and include most of the modern operational methods which meanwhile have entered in the organic chemistry laboratory techniques, in the same thorough way as has been attributed to the earlier volumes.

It is encouraging to read that aspects of thermodynamics, flow problems, heat transfer considerations have been introduced into the representations of cooling and heating in organic laboratory practice which have been carried out earlier and still to a certain degree now, from a merely empirical approach. Also applications of more modern equipment, like use of thermostats, resistance thermometers, etc., in the day-to-day practice are emphasised and described. The necessity of operational control systems for flow regulations is obviously taken as a common principle. Heat transfer coefficients are applied in the considerations and heat transfer nomenclature is used throughout. At the beginning of each chapter, one finds careful representation of theoretical developments and their practical applications as for instance, grinding, screening and classifying. It may be specially mentioned that a number of screening formulæ are proposed and their applications explained. In the classification part, the flow of solids through fluids theory is developed, resulting mainly in the friction factor formula, the application of which is further followed through. The same tendency of theoretical applications is followed in the chapter of mixing. In the chapter of operation with gases, one finds descriptions of working techniques, including the basic types of instrumentation and detailed drawings of manometers, valves, flow-meters, etc., which will give an organic chemist all the needed information about the most used equipment and their operational details.

The value of this issue is further enhanced by clear and systematic drawings, photographs of equipment, and such graphs from which the endeavour of indicating the principal factors involved becomes evident. It is further provided with an index including cumulative indices subdivided according to authors and subjects for all the nine volumes.

This new Volume III—Part II, Laboratory Engineering, will no doubt be a very helpful source of information for any organic chemist who wants to get advice in laboratory

techniques in general and in more modern techniques in special for day-to-day laboratory work, and can, therefore, be highly recommended.

E. WEINGAERTNER.

Puzzle-Math. By Dr. George Gamow and Dr. Marvin Stern. (Macmillan & Co., Ltd., London), 1958. Pp. 119. Price 8 *sh.* 6 *d.*

There can be real fun and entertainment in mathematics as the two authors have shown in this little book of brain twisters and apparent paradoxes. One of them (G. G.) is astrophysicist, author of 1, 2, 3,.....infinity, a past-master in the art of interpreting science to the general public, and the other of them (M. S.) is a consultant to Convair, one of America's largest air lines, and together they lift the reader to amusing heights. Instead of posing the puzzles and problems in the abstract, the authors have given us interesting stories, where situations are created in which the problems have to be solved by mathematical thinking.

Here is a perplexing matter which the wise Sultan had to encounter. The Grand Vizier insisted that the Sultan should pass laws immediately to control the ratio of men to women in the land's future population, as it was becoming increasingly difficult for men of distinction, but of modest means, to maintain harems approximate to their status. The Sultan stroked his beard and pondered over the matter deeply, and said that he would issue a Proclamation, instructing all women of the land that they would be permitted to continue to bear children only if their children were girls. As soon as any woman gave birth to her first son, she would thereafter be forbidden to bear any more children, on pain of banishment. The Grand Vizier and the men of distinction were extremely pleased. As years went by, however, the shortage in the harems continued to be as acute as before. Why?

The illustrations by one of them (G. G.) add to the enjoyment of the stories.

A stimulating and enjoyable book.

S. R. K.

Agriculture and Animal Husbandry in India. By Dr. M. S. Randhawa, Vice-President. (Indian Council of Agricultural Research), August 1958. Price Rs. 15.

The book with a very attractive get up of about 250 pages of printed matter with another 100 pages of excellent illustrations is divided into three sections: (i) Land, (ii) Crops and (iii) Farm Animals, Poultry and Fish.

Section I dealing with land has nine chapters and to help in a proper understanding of the varying soils of India, the earlier chapters of the section deal with geology, chief systems of rock formation and the derivation of the soils. The chapter on soils outlines the different soil groups that occur in the country and their characteristics. Some information is also provided on the fertility status of the soil groups. The chapters on 'Climate' and 'Vegetation' are a little more elaborate than others and contain all the information which every student of agriculture ought to know. There is a useful chapter on agricultural holding and its variation in different States. The information on size of holdings could have been more usefully treated in its relation to agricultural and animal husbandry regions which are however treated separately although there is a clear relation between the two. The chapter on irrigation deals with its history and development and provides full information on the various major and minor irrigation projects in progress in different States. Information on results of irrigation research is very brief and limited to schemes financed by the I.C.A.R. The information on water requirements of crops could have been supplemented with results available in Madras and Andhra Pradesh.

Section II which forms a little more than 50 per cent. of the contents of the book has 35 chapters and deals with crops classified into food crops, oilseed crops, fibre crops, other commercial crops, spices and plantation crops. Under plantation crops there is a chapter on fruit crops dealing with regions, their climate and fruits grown. Under each crop, information is provided on its distribution, cultivation practices, varieties grown and the improved strains that have become available as a result of breeding research that has been in progress in the country. No information is, however, available on the spread of the improved strains except in a few cases. The information on crops in general is necessarily very brief and more information can be gathered by referring to special publications included in the reference. That the information on some crops is more critical than on others is not the fault of the author nor a reflection on their relative importance to the country. The statement on page 105, that too wide a spacing in transplanted rice affects yields adversely is correct. But the lower yield is mainly the result of smaller number of ears per unit area, but there is

usually no fall in the number of grains per ear as has been stated. That the book does provide basic information on every crop including the less known spice crops such as cardamom and cinnamon, and plantation crops such as cinchona and lac is a commendable feature.

Section III which is the smallest in the book deals in 50 pages the classification and breeding characteristics of the farm animals and poultry. The five chapters of the section deal respectively with cattle, sheep, goats, poultry and fish. The information in this section may not fully justify the title of the book "Agriculture and Animal Husbandry in India", but nevertheless gives a good idea of the cattle wealth of India to a layman not fully acquainted with the problem. Information on breeding policy and work in progress is critical and highly useful.

The book, according to the author, has for its objective the bringing together of basic information about the important crops of India, their production, improved varieties as well as breeds of farm animals from the material already available in the Farm Bulletins, special issues of *Indian Farming* and the reports of the Indian Council of Agricultural Research and Ministry of Food and Agriculture. There is no doubt that the book has gone beyond this rather limited objective, and the author must be congratulated on providing a useful reference book that can interest administrators, agricultural officers, teachers and students. Students in the agricultural colleges can usefully supplement the information provided in the book by reference to special publications. The public who are now familiar with other publications of Dr. Randhawa know what to expect, and the present volume fully justifies their expectation. It may be mentioned in this connection that since Dr. Randhawa became the Vice-President of the I.C.A.R. the publication section has gained a great fillip, and the standard of publications has considerably improved.

A most commendable feature of the book is the inclusion of several excellent illustrations which surely add to the value of the publication. One remark that may be offered with regard to illustrations is that Plate 9 depicting a paddy crop does not represent a typical good crop of Indian rice. The illustrations and the high class get-up makes the publication too expensive (Rs. 15 per copy) to make it popular. But it is learnt that with the blocks for illustrations already available further cheaper editions are possible.

K. R.

Books Received

The Spectroscopy of Flames. By A. G. Gaydon. (Chapman & Hall, London ; India : Asia Publishing House, Bombay-1), 1957. Pp. x + 279. Price 50 *sh.*

Synchronous Motors and Condensers. By D. D. Stephen. (Chapman & Hall, London ; India : Asia Publishing House, Bombay-1), 1958. Pp. x + 500. Price 60 *sh.*

Landing Gear Design. By H. G. Conway. (Chapman & Hall, London ; India : Asia Publishing House, Bombay-1), 1958. Pp. viii + 342. Price 56 *sh.*

The Wealth of India—Industrial Products, Part IV, F-H. (Council of Scientific and Industrial Research, New Delhi-2), 1958. Pp. xvi + 304.

Physical Techniques in Biological Research, Vol. II. Edited by G. Oster and A. W. Pollister. (Academic Press, New York ; India : Asia Publishing House, Bombay-1), 1958. Pp. xv + 502. Price $ 12.80.

Isotopic Tracers in Biology : An Introduction to Tracer Methodology. By M. D. Kamen. (Academic Press, New York ; India : Asia Publishing House, Bombay-1), 1958. Pp. xii + 474. Price $ 9.50.

Biological Ultrastructure. By A. Engstrom and J. B. Finean. (Academic Press, New York ; India : Asia Publishing House, Bombay-1.) Pp. ix + 326. Price $ 8.00.

Survey of Biological Progress, Vol. III. Edited by Bentley Glass. (Academic Press, New York ; India : Asia Publishing House, Bombay-1), 1957. Pp. 332. Price $ 7.50.

The Rede Lecture—The Problems of World Population. By Sir Charles Darwin. (Cambridge University Press, London N.W. 1.) Pp. 40. Price 3 *sh.* 6 d.

Elements of Chemistry. By V. M. Parikh. (Continental Booksellers and Publishers, Tilak Road, Poona-2), 1958. Pp. 302. Price Rs. 5.

Thermodynamics of One-Component Systems. By W. N. Lacey and B. H. Sage. (Academic Press Inc., New York ; India : Asia Publishing House, Bombay-1), 1957. Pp. xi + 376. Price $ 8.00.

Advances in Veterinary Science, Vol. III. Edited by C. A. Brandly and E. L. Jungherr. (Academic Press, New York ; India : Asia Publishing House, Bombay-1), 1957. Pp. xi + 579. Price $ 13.00.

SCIENCE NOTES AND NEWS

Exceptional Sunflash Screened

An exceptional sunflash, several times the diameter of the Earth in size, was recently recorded by Soviet astronomers and filmed at the Crimean Observatory.

The Crimean Astrophysical Observatory of the USSR Academy of Sciences devotes great attention to the method of filming in studying swift processes on the Sun. For this purpose a special telescope is used—a coronagraph which permits the corona to be seen when the Sun is not in eclipse. The optical scheme of this telescope differs from the ordinary. A special metal disc covers the luminous surface of the Sun, thus creating an artificial eclipse, enabling the processes occurring beyond the rim of the chromosphere to be photographed. Such films help astronomers to make a more thorough study of solar phenomena, their dynamics and the laws governing them. Researchers have also gained the possibility, by means of fast-motion filming, to decelerate, as it were, the movements of the gigantic eruptions of incandescent solar matter. (USSR Information Department.)

Expanded Polystyrene as Thermal Insulator

Expanded polystyrene is now being made in England. It is another of the sponge-like materials without the absorbent quality of sponge because all its air-cells are separate. Those cells also are smaller than most so that the material has more the appearance and consistency of rigid India rubber than of form rubber and yet it seems comparable in weight to balsa wood—to be precise one pound per cubic foot.

The multi-cellular structure makes it specially effective as a thermal insulator. It was found in use recently in Russia in the form of flasks, containing liquid hydrogen at an extremely low temperature. It has been applied widely in England in cold storage rooms, deep freeze rooms and road and rail containers. The building industry is taking up expanded polystyrene for sound as well as heat insulation and as anti-condensation membranes in walls and ceilings.

The principle underlying its manufacture gives the clue to its qualities. Small polystyrene beads incorporating an expanding agent are heated to swell to 60 times their original size. They are then fused together into boards or blocks, white in colour and of good mechanical strength, which can be worked with the normal carpenter's tools.

A type of this material is now being manufactured in India and is expected to find a wide market.

Telephony *via* the Moon

It has been known for several years that voice communication using the moon as a reflector was possible when long wavelength signals were utilized. Recent researches at the University of Michigan indicate that very short-wave radio or radar signals, which can be used in voice transmission, bounce off the moon without appreciable loss in quality. This means that the curvature of the earth no longer need be a factor in limiting communication distance—a radar signal has to travel in a straight line—so long as both transmitting and receiving equipment can "see" the moon.

It was thought that, because of the jagged mountains and craters which are known to exist in the moon, the moon would appear rough to a radar original. But a short wave signal requires only a few square feet area to be reflected. The moon has such areas that are smooth and hence the radar signals are reflected without a loss in quality.

The Michigan Uuiversity investigations show that very short wavelengths of about an inch give such improvement in clarity that it is commercially feasible now to set up a world-wide network of stations by using the moon as a reflector. (*Jour. Frank. Inst.*, August 1958.)

"Pioneer" used as a Repeater Station

According to the U.S. Air Force disclosure, scientists at Manchester "talked" to colleagues in Florida and Hawaii through space using the American "Pioneer" moon rocket as a radio repeater station. Scientists had long discussed the idea of using a satellite or space station as a connecting link between two distant points on earth, but this was the first practical proof that such a system was feasible. The moon probe tracking stations at Jodrell Bank, Cape Canaveral and Hawaii communicated with each other in the international code signals on the 108 megacycle band.

New Device for Safety in Coal Mines

The sudden eruption of gases in a coal mine is a dangerous thing. On the initiative of Academician A. Skochinsky a seismo-acoustic station was set up at the Yuny Kommunar Pit in the Donets Basin.

A special instrument called a geophone is inserted into a 3-4-metre-deep hole drilled at the face. It catches extremely weak sound vibrations originating in the coal seams as a result of mechanical changes in the rock. The sounds are amplified by an electronic explosion-safe amplifier and, with the aid of a miniature radio station, are relayed to the surface laboratory where they are tape-recorded.

When the tape is studied, a complete idea of noises in the seam is gained. If the hourly rate of sound impulses increases, the operator reports the possibility of an eruption seven to twenty hours in advance and the workers leave the dangerous zone.

5 Million Atmospheres Pressure Attained

Soviet scientists, of the Laboratory of Physics of Super-High Pressures, claim having attained a record pressure of 5 million atmospheres. The method consists in imparting tremendous speed (over 8 kilometres per sec.) to a plate of some material and bringing it into collision with another plate which resulted in the explosion of both. Techniques have been evolved to measure within infinitesimal fractions of a second the pressure developed in the impact and to investigate the state of matter.

The new high pressure record will make it possible to gain a better insight into the laws governing the phenomena occurring in the depths of the earth and the structure of the earth's core. Super-high pressures cause highly peculiar chemical transformations and create new synthetic substances. Possibly diamond could be produced out of graphite by the explosion technique. Important results might also be obtained for students of molecular structure of matter and crystallographers.

These methods greatly widen experimental possibilities in high pressure physics. They have already carried out measurements of the dynamic compressibility of certain metals within the range of pressures from 400 thousand to a 4 million atmospheres. The greatest increase of density—2·26 and 2·28 times—has been registered with lead and bismuth respectively, that is, with elements possessing great atomic volumes. It has been established that the reorganization of crystalline structure occurring at enormous pressures is unbelievably rapid. Now physicists are investigating the transparency and electrical conductivity of instantaneously compressed materials. It has been proved experimentally that at great pressures, insulators become conductors.

Food and Oxygen from Algae

Photosynthesis, which replenishes life-sustaining oxygen in an endless cycle on earth, may enable man to travel in outer space and under the oceans for unlimited periods of time.

From a species of algæ discovered by Constantine Sorokin at the University of Texas, a new strain of algæ has been developed which increases 1,000 times a day as compared to only 8 times a day of the earlier types.

Very dense plant cultures of this fast-acting algæ are irradiated with extremely intense light—many times the intensity of the brightest sunlight—from a new type of lamp recently developed by the G.E.C.

Carbon dioxide respirated by men is removed from the closed atmosphere of sealed containers by the algæ, which in turn produce oxygen in the same manner that green plants do on earth. In addition, the algæ also produce large quantities of highly nutritious food material (*e.g.*, proteins and vitamins).

Cultures of the new algal strain, nearly as thick as blood, were pumped very rapidly past the light, which is scarcely bigger than a pencil. This provided rapid stirring to utilize the well-established advantage of intermittent illumination. The alternate periods of high intensity light flashes were followed by dark rest periods for recovery. The algæ growing in this closed circle system removed carbon dioxide and produced large quantities of oxygen and food. (From Report of T. A. Gaucher of General Dynamics Corporation, N.Y.)

Belgian Scientist Terms X-Ray Dangers Greater than Fall-out

A warning of the atomic radiation danger in the over-use of X-ray examination was given recently by Prof. Zenon M. Bacq, of Liège University, at the Fourth General Assembly of the Council for International Organizations of Medical Sciences meeting at UNESCO House in Paris.

Prof. Bacq, former Chairman of the United Nations Scientific Committee on the Effects of Atomic Radiation, described this danger with facts and figures.

"The genetically significant dose of radiation from natural sources is 3 rem for a period of 30 years," he said. "The dose distributed to gonads by atomic fall-out during the same period will be about ·01 rem—that is, 300 times less than the natural dose, if atomic tests are terminated at the end of this year.

"The dose distributed by physicians in countries where medical facilities are highly developed is from ·5 to 5 rem—that is, from 50 to 500 times more than atomic fall-out or, in other words, a genetically significant dose as great as natural radiation."

Pointing out the need to draw the attention of physicians in general to the necessity of diminishing the quantities of radiation administered during X-ray diagnosis, Prof. Bacq went on:

"Specialists believe that, if all those who conduct X-ray examinations were well-trained and equipped with appropriate apparatus, and that if physicians did not ask their colleagues, the X-ray specialists, to conduct useless or relatively useless examinations, it would be possible to lower the dose distributed to the population by at least a quarter of its present state—and to do so without doing the slightest harm to the precious contribution of X-ray examinations to the diagnosis of illness."—UNESCO.

Streptomycin Dermatitis

Sensitivity to streptomycin is very common. Since the first account by Heilman *et al.* (1954) a variety of dermatoses have been reported in patients treated with this antibiotic. The list includes pruritus, erythema, eczema, photosensitivity, articaria, exfoliative dermatitis, and purpura. Occasionally, the mucous membrances are affected, and cheilitis, stomatitis, and ulceration of the tongue have been described. Strauss and Warring (1947) reported an outbreak of dermatitis in nurses handling streptomycin, 4 out of 12 developing a rash on the hands and eyelids. Further reports (Rauchwerger *et al.*, 1948; Stringfellow, 1948; Wood, 1956) confirmed the fact that nurses giving streptomycin injections were liable to develop sensitivity to the drug. (*Brit. Med. J.*, No. 5048, June 14, 1958, p. 1378.)

International Oceanographic Congress

The American Association for the advancement of Science in co-operation with UNESCO and the *Special Committee on Oceanic Research of ICSU* is planning and organizing an International Oceanographic Congress to be held during a two-week period from 30th August to 12th September 1959, at the United Nations Building, New York.

The purpose of the Congress is to provide a common meeting ground for all sciences concerned with the oceans and the organisms contained in them. The Congress will be devoted to the fundamentals of the marine sciences rather than to their applications.

It has been agreed by the Organizing Committee that the Congress will be centered around five symposia on the oceans: (1) The history, (2) The boundaries, (3) The deep sea, (4) Dynamics of organic and inorganic substances, (5) The marine life regime.

This notice should be considered as preliminary. Until further notices are issued, titles and abstracts of papers, which are publicly solicited by this notice, and any other correspondence should be sent to: Dr. Mary Sears, Chairman, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, U.S.A.

Symposium on "Nuclear Fuel Cycles"

The Institute of Physics, one of the constituent bodies of the British Nuclear Energy Conference, is arranging a Symposium in London on "Nuclear Fuel Cycles" on 22nd and 23rd January 1959.

The programme is as follows: Session 1. (*a*) Long-term reactivity changes, (*b*) Theory of once-through fuel cycles, (*c*) Perturbations due to fuel cycles;

Session 2. Optimization of fuel cycles for nuclear power stations;

Session 3. Fuel cycle operational problems.

Application forms for tickets to attend the Symposium are obtainable from the Secretary of the Institute of Physics, 47 Belgrave Square, London S.W. 1, and should be returned as soon as possible.

Symposium on "Iron and Steel Industry in India"

The Symposium will be held at the National Metallurgical Laboratory, Jamshedpur, from 4th to 7th February 1959 and will provide an international forum for establishing personal contacts and facilitating exchange of ideas on the development of iron and steel industry in general and that of India in particular.

The scope of the Symposium will cover broadly the following: (1) Raw materials, their assessment and preparation, (2) Physical chemistry of iron and steel production; (3) Recent technological advances in iron and steel production metallurgy in various parts of the world, (4) Casting and metal-working techniques,

(5) Alloy, tool and special steels production technology, (6) Present status and future expansion of iron and steel industry in India, (7) Utilisation of by-products of iron and steel industry.

Further particulars can be had from the organisers, National Metallurgical Laboratory, Jamshedpur-7.

Symposium on "The Nature of Coal"

It is proposed to hold a Symposium on the above subject at the Central Fuel Research Institute, India, from Monday, the 9th to Wednesday, the 11th February 1959. The Symposium is to be held under the joint auspices of the Central Fuel Research Institute, the Institute of Fuel (India Branch) and the Institute of Chemists, India. The Organizing Committee have arranged for six sessions as listed below: Session I: Origin and Systematics of Coal; Session 2. Petrographic and X-ray Studies of Coal; Session 3: Ultra-Fine Structure of Coal; Session 4: Coal Constitution: Physical Methods; Session 5: Coal Constitution: Chemical Methods; Section 6: Physico-Chemical Properties of Coal.

Further particulars can be had from the Director, Central Fuel Research Institute, P.O. Fuel Research Institute, Dhanbad Dist., Bihar, India.

Public Health Administration in U.S.S.R.—Study Tour Organized By WHO

Twenty-three senior public health administrators from various countries of the world will participate on a six-week study tour of U.S.S.R., sponsored by WHO. The group will be led by Dr. J. Peterson, Director of the Division of Organisation of Public Health Services at WHO Headquarters in Geneva. The Indian member of the group is Dr. N. Jungalwalla, Director, All-India Institute of Hygiene and Public Health, Calcutta.

Index to Plant Chromosome Numbers

The second issue of the *Index*, compiled from nearly 300 journals published in 1957, is now ready for distribution. There are around 2,000 listings of original chromosome counts from the entire plant kingdom and a bibliography of 196 papers from which the listings were taken. The price of each issue is $ 1. Orders for subscriptions may be sent to: Dr. C. Ritchie Bell, Department of Botany, University of North Carolina, Chapel Hill, North Carolina, U.S.A.

Present Trends on Zoological Research in India

Under the auspices of the Zoological Society of India, it is proposed to hold a Symposium on the above subject at Delhi on the 19th and 20th January 1959. Intending participants should send apstracts with the full text of their papers to the Hon. Secretary-General, Zoological Society of India, Department of Zoology, Andhra University, Waltair, by 20th December 1958.

Change of Dates of "Symposium on Fungus Diseases in India"

The above Symposium previously notified to be held in December 1958 (*Curr. Sci.*, 1958, 27, 327), has been deferred due to unavoidable reasons. The final dates for the Symposium are February 5 and 6, 1959. Last dates for sending abstracts (not exceeding 300 words) and full papers have been extended to October 30 and December 15, 1958, respectively. Dr. C. G. Pandit, Director, Indian Council of Medical Research, New Delhi, has kindly consented to preside over the Symposium. Scientists from the U.S.A. and U.K. are expected to participate in the Symposium.

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Physics to Mr. D. V. G. L. Narasimha Rao for his thesis "On Certain Theoretical and Experimental Studies in Dielectrics at Microwave and Radio Frequencies" and the Degree of D.Sc. in Technology to Mr. P. Dakshinamurty for his thesis "Vapour Liquid Equilibria of Binary and Ternary Systems".

Dr. Buddhadev Sen (Calcutta) and Dr. Bharat R. Sant (Banaras) are working as Visiting Assistant Professors in the Chemistry Department of the Louisiana State University, Baton Rouge, U.S.A., on "Methods of Detection and Determination of Air-Polutants", using for their study the most modern technique of Gas Chromatography.

Dr. Anil K. Mukherji (Allahabad) also working as Visiting Assistant Professor at the Louisiana State University is engaged in Microchemical Spot Test Analysis using the Weisz Ring Oven and the solvent extraction techniques.

Dr. B. Suseela (Hyderabad), recipient of Special Skinner Fellowship, is doing research at Mount Holyoke College, Massachusetts, working on Problems Relating to Molecular Structure of Organic Compounds and Their Complexes with Inorganic Metal Ions.

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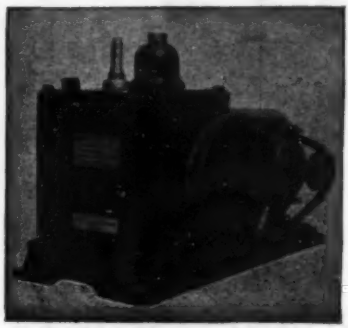

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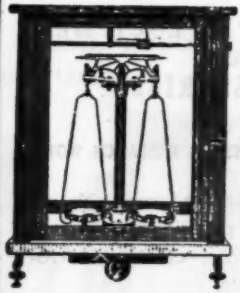

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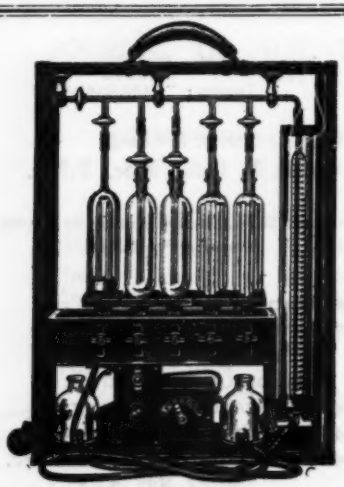

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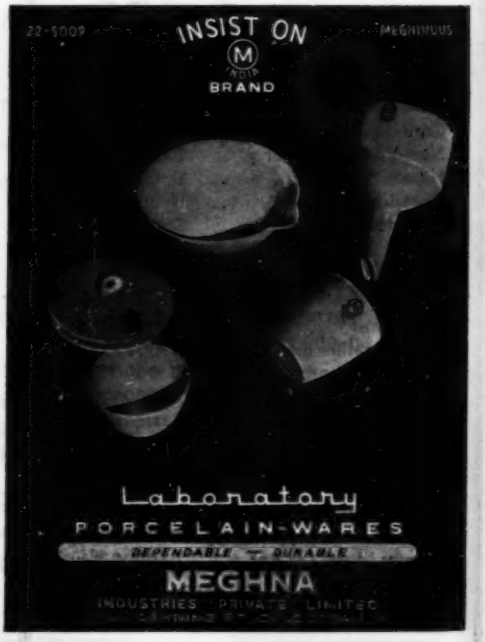

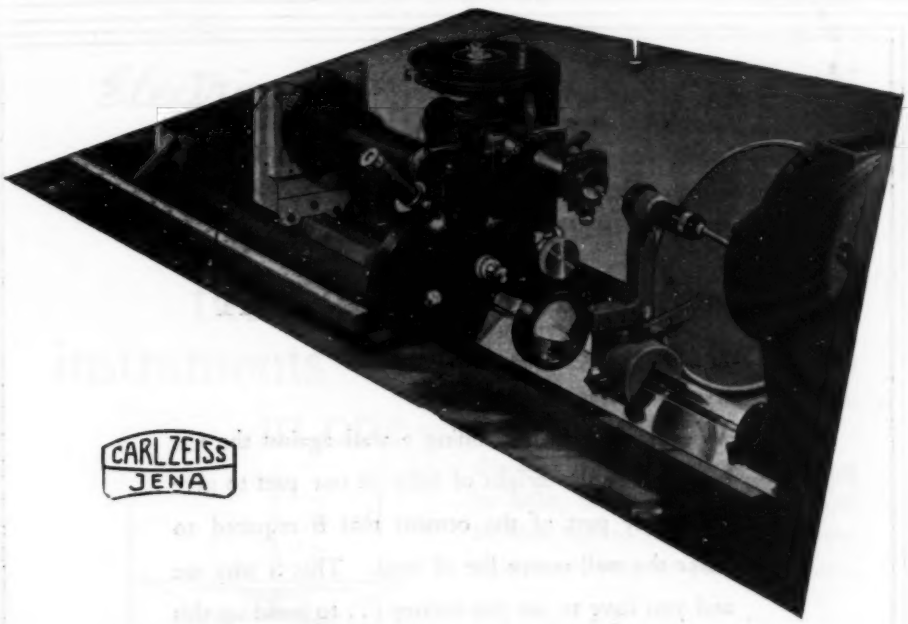

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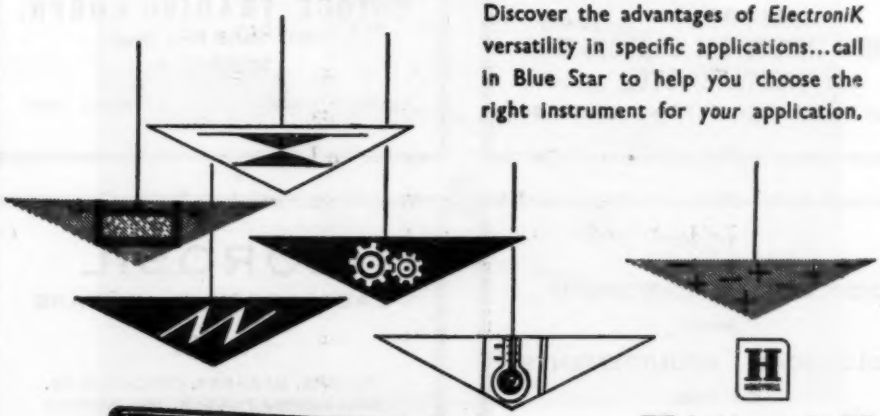

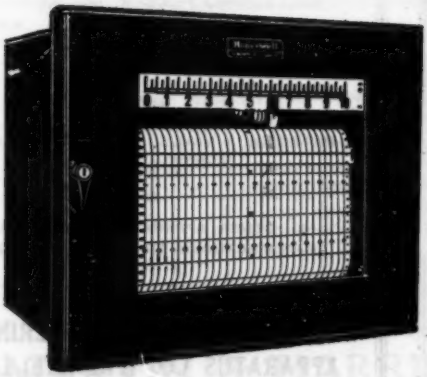

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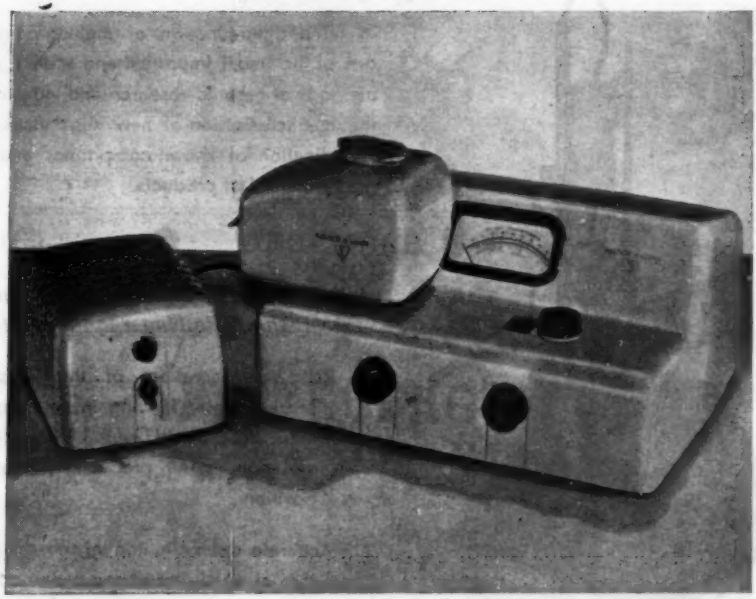

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